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ARMY COLLEGE FUND COST-EFFECTIVENESS STUDY

BY

SYSTEMS RESEARCH AND APPLICATIONS CORPORATION
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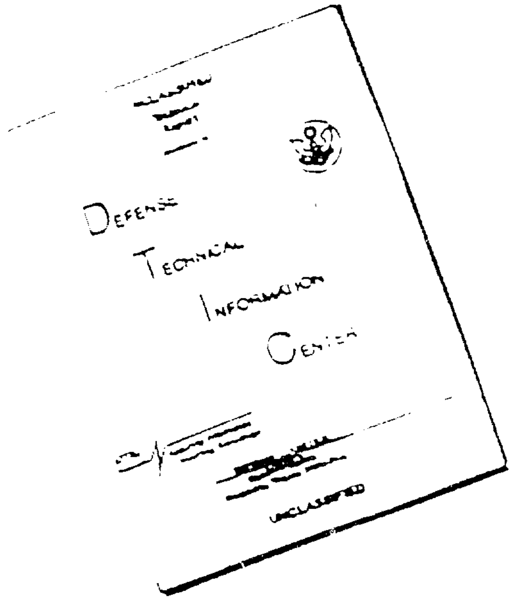

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The Army College Fund (ACF) has been a key element in the Army's strategy to recruit high quality individuals since FY82. However, the cost-effectiveness of the ACF as a force-manning tool has been a subject of debate since its introduction, primarily due to uncertainty about the values of key parameters required for a cost-effectiveness analysis. To improve the foundation for a cost-effectiveness analysis of the ACF, we first conducted three research efforts using newly-available data: (1) estimation of an enlistment supply model to determine the enlistment elasticity associated with ACF benefits, (2) estimation of first-term attrition and reenlistment models to assess the retention effects of the ACF, and (3) an analysis of education benefits usage. The results from these efforts were combined with other research in the area to provide the key parameters required for the cost-effectiveness analysis. Using a reasonable range of assumptions, we found that the ACF, at levels recently used, is a cost-effective recruiting tool.

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EXECUTIVE SUMMARY

The Army College Fund (ACF) has been a key element in the Army's strategy to obtain high-quality recruits since FY82. The ACF offers significantly increased education benefits for qualifying individuals: high school graduates, scoring in the top half on the Armed Forces Qualification Test, who enlist in designated occupations. Currently, all recruits can participate in the New GI Bill, which has maximum benefit levels of $9,000 for 2-year enlistments and $10,800 for 3- and 4-year enlistments. Eligibility for the ACF increases potential benefits by $8,000 for a 2-year enlistment, $12,000 for a 3-year enlistment, and $14,400 for a 4-year enlistment.

The effectiveness of the ACF in increasing high-quality enlistments was established during the FY82 Education Assistance Test Program, but the *cost*-effectiveness of the ACF has been a subject of debate since its introduction. To a large extent, the debate stems from uncertainty about three key parameters required to evaluate ACF cost-effectiveness:

- **ACF enlistment supply effects.** Although there is a reasonable consensus across studies about the effect of increasing education benefits on total high-quality enlistments, less is known about the effects by term of service or for changes in benefit levels versus occupational coverage.

- **ACF retention effects.** Because education benefits are typically used after separation from the military, it is possible that the reenlistment rates of ACF-eligible soldiers are lower than otherwise similar soldiers with less generous benefits. This means that the ACF should be evaluated using a measure of effectiveness which includes both enlistment and retention effects, such as man-years.

- **ACF costs.** The delayed use of education benefits also means that actual data on ACF benefit usage has only recently become available. Previous evaluations of ACF cost-effectiveness have had to rely on usage experience from the Vietnam-era GI Bill, which is suspect because of the differences between that bill and the new GI Bill.

The main objective of this project is to reassess the cost-effectiveness of the Army College Fund as a force-manning tool. To provide a more solid basis for the analysis, however, we first developed the following new estimates of the key parameters:

- We estimate an econometric model of high-quality male contracts using monthly battalion-level data from FY81 through FY89. This model includes an education benefits variable that measures both the level of benefits and occupational coverage.

- We estimate multivariate models of both first-term attrition and reenlistment which include the level of education benefits for which a soldier was eligible at enlistment. We find no difference in attrition between soldiers with and without

ACF eligibility, other characteristics held constant. We do, however, estimate that ACF-eligibles have lower reenlistment rates, other things being equal.

- Using the FY82 Education Benefits Cohort File, which tracks benefits usage through July 1989, we estimate a model of usage as a function of soldier characteristics and the maximum benefits offered. Predictions of usage from this model are the basis for new estimates of the per accession cost of the ACF.

We combine the results from this research with those from other studies to evaluate the cost-effectiveness of the current Army College Fund. Our conceptual approach is straightforward. First, we reduce ACF benefits by 50% and calculate the resulting loss in high-quality male man-years. Then, we increase first-term compensation for high-quality soldiers enough to replace the lost man-years. With effectiveness held constant, we evaluate the change in selected force-manning costs, including recruiting incentives and initial training costs.

Over what we believe are reasonable ranges for the key parameters, we estimate that substituting additional first-term compensation for reduced ACF benefits would *increase* incentive and training costs. Thus, the current ACF program appears to be a cost-effective force-manning tool.

PART I

ARMY COLLEGE FUND

COST-EFFECTIVENESS ANALYSIS

1. INTRODUCTION

Since FY82 the Army College Fund (ACF) has been a significant component of the Army's strategy to enlist individuals from the "high-quality" youth population -- high school graduates who score in the upper half on an entry examination. The effectiveness of the ACF as a recruiting tool was established during the FY81 Education Assistance Test Program, but the *cost*-effectiveness of the ACF in comparison with other recruiting incentives has been more or less continuously debated since its introduction. Much of the debate stems from uncertainty about certain key parameters required for a cost-effectiveness analysis. Because of the lag between the offer and use of education benefits, only recently could some of these parameters be estimated from the actual behavior of ACF participants.

This report has two parts. Using updated data sources, we first develop new estimates of the enlistment supply effects, retention effects, and costs of the ACF. Then, combining these results with other available research, we evaluate the cost-effectiveness of the ACF as a force-manning tool.

In the remainder of this introduction, we outline the features of the ACF program (Section 1.1), discuss key issues raised in evaluating ACF cost-effectiveness (Section 1.2), and present the study objectives and organization (Section 1.3).

1.1 The Army College Fund

The ACF offers qualified recruits education benefits that are in addition to those provided by education benefits programs open to all recruits. To be eligible for the ACF, a recruit must:

- Be a high school graduate;
- Score in the top 50% of the Armed Forces Qualification Test (AFQT), a pre-enlistment exam; and
- Select an occupation that is designated for ACF participation.

The list of designated occupations has varied over time. In FY82 ACF occupations represented 64% of all high-quality male accessions. Occupation coverage increased steadily to 80% in FY84 and

declined to 65% again in FY89.[1]

The ACF has been combined with two education benefits programs available to all soldiers: the Veterans Education Assistance Program (VEAP) from FY82 through FY85 and the New GI Bill since FY86. To receive benefits under the ACF-VEAP program, a soldier had to contribute between $25 and $100 per month for 12 consecutive months or contribute a lump sum payment of at least $300. Contributions were matched 2 for 1 up to a maximum contribution of $2,400 for soldiers enlisting for a 2-year initial term and $2,700 for 3- and 4-year enlistments. If also eligible for the ACF, a soldier received an additional amount (called a "kicker") which varied with the enlistment term and the number of months actually served. Soldiers enlisting for 2 years could receive $4,400 after 12 months of service, plus an additional $300 per month up to a maximum of $8,000. Soldiers with 3- and 4-year enlistments could receive $4,800 after 12 months of service and $300 per additional month up to a maximum of $12,000. Table 1 summarizes the maximum education benefits available under the ACF-VEAP program.

To receive either the matching VEAP payments or ACF benefits, a soldier had to separate with better than a dishonorable discharge or successfully complete the first term. Payments were made in monthly installments that included a portion of the soldier's contributions, VEAP matching payments, and any ACF benefits. Unused contributions under the VEAP program were refundable.

In July 1985 VEAP was replaced with the New GI Bill, the program currently in place. To receive ACF or GI Bill benefits, a soldier must make nonrefundable contributions of $100 per month for the first 12 months of service. No lump-sum contribution option is available. GI Bill benefits (including returned contributions) are $9,000 for 2-year enlistments, which are paid at $250 per month for 36 months, and $10,800 for 3- and 4-year enlistments, which are distributed at $300 per month over a 3-year period (see table 1).[2] Those who qualify for the ACF receive kickers of $8,000 for 2-year terms, $12,000 for 3-year terms, and $14,400 for 4-year terms. To receive either the GI Bill or ACF benefits, a soldier must have a high school diploma, or its equivalent, by the end of the

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1. See Appendix A for annual coverage estimates from FY82 through FY89.

2. Enlistments for 2 years of active duty and 4 years in the Selected Reserves are eligible for the same benefits as 3-year enlistments.

Table 1. Maximum benefits under ACF, VEAP and New GI Bill

Program	Enlistment Term 2 Years	3 Years	4 Years
ACF + VEAP:			
Soldier contribution	2,400	2,700	2,700
VEAP matching benefits	4,800	5,400	5,400
ACF benefits	8,000	12,000	12,000
Total benefits	$15,200	$20,100	$20,100
ACF + New GI Bill:			
Soldier contribution	1,200	1,200	1,200
GI Bill benefits	7,800	9,600	9,600
ACF benefits	8,000	12,000	14,400
Total benefits	$17,000	$22,800	$25,200

first term of service and be honorably discharged (or complete 20/30 months of service).

In FY82 approximately 24,000 high-quality recruits entered occupations that made them eligible for the ACF. Although the number of high-quality enlistments and ACF occupational coverage were about the same in FY82 and FY89, by FY89 the number of ACF-eligible enlistments had dropped to approximately 16,000. This reduction was primarily due to a policy change in January 1986 which forced high-quality recruits to choose between the ACF and an enlistment bonus if both were offered for enlisting in a particular occupation. Before that time, a recruit could take advantage of both incentives.

1.2 ACF Cost-Effectiveness Issues

There are three research questions underlying the continuing debate over the cost-effectiveness of the ACF. The first question concerns the primary purpose of these benefits, which is to increase the supply of high-quality recruits to the Army while channeling them into selected skills. The effect of the ACF on enlistment supply therefore is of central importance; and it has received the most

attention from researchers, starting with the analysis of the Education Assistance Test Program (EATP). While there is some consensus on the total enlistment supply effect of the ACF, we still know relatively little about how that effect varies by term of service and for changes in the level of benefits versus changes in the number of ACF-covered occupations.

The second question concerns the cost of the ACF program. Usage of ACF benefits typically occurs a number of years after enlistment, both because most benefits are used after separation at the end of the first term and because the maximum monthly payment is limited by program regulations. Since the ACF only began in FY82, data on actual ACF usage and, therefore, costs have only recently become available.[3] As a result, previous analyses of the cost of the ACF were extrapolations based on experience under the Vietnam-era GI Bill. Given the differences in the programs, it is not surprising that these estimates have proven to be quite inaccurate. In general, cost estimates for the ACF have been falling. For example, the DOD actuary has lowered its ACF cost estimates, which are used to determine the budget costs of the program, as more experience-based data have become available.

Education benefits are likely to be most attractive to recruits who want to obtain a college education. Moreover, the benefits may provide the soldier with an additional incentive to leave the Army to use them. Therefore, recruits induced to enter because of education benefits may reenlist at lower rates than other recruits. However, because of the minimum service requirement to receive any benefits, ACF recruits may also have lower first-term attrition than otherwise similar recruits who are not eligible for the program. These potential retention effects of the ACF imply that a cost-effectiveness analysis should use man-years rather than enlistments as the measure of effectiveness. Until recently, however, there have been no estimates of the size of the effects of the ACF on first-term attrition and reenlistment.

1.3 Study Organization

There are two parts to this study. To provide a more solid basis for the cost-effectiveness

3. For example, FY89 data is required to observe benefits usage over a 3-year postseparation period for members of the FY82 cohort who enlisted for 4 years and left after their first term of service.

analysis, we first develop new estimates of the three key parameters discussed above: the enlistment supply effects of the ACF, ACF cost per enlistment, and the retention effects of the ACF. The results from this research are described only briefly in this part of the report. We present the details of the three analyses in Appendices A, B, and C.

Combining our results with previous research, when available, we then estimate the cost-effectiveness of the ACF compared with other recruiting tools. The next section discusses our approach to the cost-effectiveness analysis, including the selection of key parameter values and other assumptions. Section 3 presents the results.

2. COST-EFFECTIVENESS FRAMEWORK

The goal of cost-effectiveness analysis is to determine whether a particular activity is being accomplished in an economically efficient manner. Using the current mix of resources and the resulting output as a reference point, the analyst "alters" the mix of resources so that the same level of output is still being produced. If the new mix of resources costs less, then it is said to be cost-effective in comparison with the current mix. Our application of cost-effectiveness analysis to the ACF follows this approach exactly and can be described by the following four steps:

1. Reduce the level of ACF benefits by 50%;
2. Estimate the resulting reduction in high-quality man-years that would have occurred in FY89;
3. Increase the monetary compensation of high-quality recruits to produce an offsetting increase in man-years; and
4. Assess the change in costs resulting from this substitution of incentives.

In the remainder of this section, we detail the calculations required for each of these steps. Those calculations are based on methodological assumptions, which can be debated, and key parameters, which may be uncertain. Although we select one set of assumptions and parameter values for our "baseline" case, we test the sensitivity of the results obtained in that baseline by varying both assumptions and parameters. Those variations are also outlined below.

2.1 Reducing ACF Benefits

One could begin the analysis by increasing or decreasing ACF benefits. We selected the latter option because it was more relevant to the policy issues being debated at the beginning of this study.[4] In the baseline case, we reduce benefits by 50% from the FY89 levels of $8,000, $12,000, and $14,400 for 2-, 3-, and 4-year enlistments, respectively. The size of the reduction is somewhat

4. The cost-effectiveness methodology developed for this report was implemented in a spreadsheet program, which has been supplied to the Army. This program can be used to evaluate the cost-effectiveness of alternative changes in ACF benefits.

arbitrary. A 50% cut represents a significant reduction in the program; but it is also within the range of education benefits variation that has been used to estimate both the enlistment supply and retention effects of the program. This reduces the uncertainty associated with the man-year estimates.

2.2 Estimating Resulting Man-Year Loss

When ACF benefits are reduced, man-years will change because of two factors: (1) a smaller supply of recruits and (2) ACF effects on soldier retention. Estimating these changes is perhaps the most complicated part of the cost-effectiveness analysis. We begin with the enlistment supply effects.

Enlistment Supply. Across different data sets and methods, there is a reasonable consensus in the research literature on the relationship between the amount of education benefits offered and the supply of high-quality enlistments. Here we summarize one previous study and the results of our own enlistment supply analysis; a more detailed review is found in Appendix A.

Analyzing the results from the FY81 EATP, Fernandez (1982) found a 9.1% decrease in total high-quality male enlistments for the Army when SuperVEAP, which had total benefits of $14,100 for 4-year enlistments, was offered instead of UltraVEAP, which had the same benefits as the FY82 ACF. To isolate the supply effect of education benefits, Fernandez controlled for other differences in the potential recruit population across test cells both through the design of the test program and in a multivariate analysis. The change in benefits between UltraVEAP to SuperVEAP implies an elasticity of total high-quality male enlistments with respect to education benefits of .11. That is, for every 1% increase in education benefits, high-quality male enlistments in all occupations are estimated to increase by .11%.

Our estimate of the ACF enlistment supply elasticity is derived from a multivariate model of high-quality male enlistment contracts estimated with monthly battalion-level data for the years FY81 through FY89. As explanatory variables, the model includes a measure of military pay relative to civilian earnings, the unemployment rate, production recruiters, high-quality and other missions, the qualified military available population, various policy change indicators, and a measure of available education benefits. That measure captures changes in both the level of education benefits, using the discounted present value of maximum education benefits (ACF + VEAP or ACF + GI Bill, as

appropriate) deflated by a college cost index, and in program coverage, using an accession-weighted proportion of the Military Occupation Specialties (MOSs) designated for ACF participation. With this model, we estimate an ACF elasticity of .14, slightly higher than the EATP results.[5]

These results, as is the case with almost all of the existing enlistment supply literature, focus on the relationship between high-quality *male* enlistments and education benefits. In addition, during the period used to estimate this relationship, there were relatively few enlistments over 4 years. Given these limitations, in the cost-effectiveness analysis we only consider the man-years generated by a subset of high-quality recruits -- males enlisting for terms of 2, 3, and 4 years. In FY89 this represented about two-thirds of the total high-quality accession cohort. There is simply not enough solid evidence to include females or soldiers enlisting for longer terms of service in the analysis.

In the baseline case of the cost-effectiveness analysis, we use the .14 ACF supply elasticity estimated in our analysis; but we also evaluate ACF cost-effectiveness when the elasticity is .11. In either case these elasticities are used to estimate the accession loss that would occur with reduced ACF benefits in the following way. A 50% cut in ACF benefits represents an average reduction of 27% in the *total* education benefits offered under the combined ACF-GI Bill program.[6] This implies a drop in total high-quality male enlistments from 3.0% (27 x .11) to 3.8% (27 x .14).

Because expected man-years per accession vary with the length of the initial term of service (see below), we need to know where the enlistment losses will occur. In our enlistment supply analysis, we estimated the effects of education benefits by term of service using a data set with monthly observations only at the recruiting command level. While suggestive, the results from these models had large standard errors. As a second best procedure, in the cost-effectiveness analysis we simply allocate the total reduction in enlistments according to the proportion of FY89 ACF enlistments by term.

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5. When the benefits level and coverage portions of the ACF variable were allowed to have separate effects, the elasticity with respect to changes in benefits was .11 and with respect to changes in coverage was .23. This result, however, was sensitive to the specification of the model (see Appendix A).

6. It is the percentage change in total benefits that is relevant because that is how the elasticities are defined.

Man-Years per Accession. Expected man-years per accession is estimated by enlistment term and level of ACF benefits as

$$(1) \qquad Y_t^b = FY_t^b + R_t^b\, CY,$$

where Y is expected man-years for a soldier enlisting for t years with benefits level b, FY is first-term man-years, R represents the reenlistment rate, and CY is expected years of service beyond the first term. Three benefits levels must be considered in the analysis: FY89 ACF benefits, a 50% reduction from that level, and no ACF benefits (for high-quality recruits entering with an enlistment bonus or no enlistment incentive).

We predict both first-term man-years and reenlistment rates from econometric models of retention behavior. These models express retention as a function of a variety of demographic and service-related characteristics, including the level of education benefits for which a soldier was eligible at enlistment. In the cost-effectiveness analysis, we need to predict how man-years per accession will change with a drop in education benefits *for the same accession cohort*. With a multivariate model we estimate the effect of education benefits on retention, holding constant other soldier characteristics, which allows such predictions. Our models are estimated with the FY82 Education Benefits Cohort File (EBCF), which includes a 10% random sample of all Army enlisted accessions in 1982 and tracks both their retention and education benefits usage through July 1989. The specification and estimation of the first-term attrition and reenlistment models are described in Appendix C, as well as the details about how predictions are generated from these models.

For the cost-effectiveness analysis, the key findings from this retention research concern the estimated variation in FY and R with the level of education benefits. That is, what are the directions and magnitudes of the ACF retention effects? Consistent with the available literature, we find no significant difference in attrition rates by ACF eligibility.[7] Therefore, we use one set of values for expected first-term man-years, as shown in table 2.

7. In addition to the research reported here, the relationship between first-term attrition and the level of education benefits is investigated in Schmitz (1988), Hogan et al. (forthcoming), and Warner and Solon (forthcoming). These papers plus Smith et al. (forthcoming) also examine the reenlistment-education benefits link.

Table 2. Man-year factors

	Enlistment Term		
	2 Years	3 Years	4 Years
First-term man-years*	1.75	2.55	3.14
Reenlistment rates*			
FY89 ACF benefits	.295	.433	.489
No ACF benefits	.322	.479	.544
Man-years after first term	7.19	7.19	7.19

*Predicted from models of first-term attrition and reenlistment. See Appendix C for details.

We do, however, find that reenlistment rates are lower for soldiers who are ACF-eligible than for otherwise similar soldiers who are not eligible -- between 2.7 and 5.5 percentage points depending on the enlistment term. These results are also consistent with the findings from other studies that have examined the reenlistment rate-education benefits relationship. Combining the first-term attrition and reenlistment results, our analysis confirms the hypothesis that the average man-years produced with an ACF accession will be smaller than with other enlistment incentives. This, of course, does not necessarily imply that the ACF is not cost-effective. Total man-year effects and costs must be considered to reach a conclusion on this point.

When ACF benefits are reduced, the average man-years for all accessions increases for two reasons. First, there are fewer ACF enlistments with their lower expected reenlistment rate and, therefore, man-years. Second, those who still enlist under the ACF option have lower benefits and, presumably, higher reenlistment rates than under the current program. In our baseline calculations, we increase the reenlistment rates for ACF enlistments under the reduced program so that they lie between the FY89 ACF and no-benefits rates shown in table 2. This may overstate the adjustment that would occur. Our analysis of the link between education benefits and reenlistment rates measures both the pull of benefits at the reenlistment point and the fact that college-bound recruits are more likely to enlist for higher benefits. As the latter effect would still be present to some degree in a reduced-benefits ACF, we also analyze ACF cost-effectiveness assuming an adjustment that is only

50% of the estimated effect.

The final component of the average man-years calculation, man-years after the first term, is calculated assuming typical Expiration Term of Service (ETS) and non-ETS retention rates through year of service 20.[8] As shown in equation 1, above, we assume that ACF-eligible and other high-quality soldiers have the same expected years of service after the first term.

Two additional issues related to the calculation of man-years deserve comment. In measuring effectiveness by total man-years, we ignore the differences in productivity between junior and senior man-years. Any attempt to assign different values to man-years based on productivity is somewhat arbitrary because there is little concensus on the quantitative relationship between seniority and productivity in the enlisted ranks. Because we do not include productivity differences in the analysis, we also ignore the compensation differences between junior and senior man-years. What is the effect of these assumptions on our results? In exploratory calculations, we assigned productivity weights to man-years based on the growth in basic military compensation by year of service -- a reasonable approach in the absence of hard data -- and also included compensation costs. The results were identical to those presented here.

Second, we only consider active duty man-years in our cost-effectiveness analysis. To the extent that ACF-eligible soldiers who leave at higher rates after their first term also enter the Selected Reserves, our baseline calculation is somewhat biased *against* a finding of cost-effectiveness for the ACF. However, using Total Force man-years in the analysis would require weighing active duty and reserve man-years by their respective contribution to defense "output", another topic where there is little research to guide us.

2.3 Raising High-Quality Compensation to Restore Man-Years

To return to the FY89 level of man-years in the cost-effectiveness analysis, we increase the compensation of high-quality recruits through a bonus-like payment targeted to this population.

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8. In particular, we use second-, third-, and fourth-term reenlistment rates of 0.6, 0.8, and 0.9, respectively; and a non-ETS continuation rate of 0.95.

Although the existing enlistment bonus is usually viewed as a tool for directing recruits to particular occupations rather than increasing total enlistments, there are two reasons for using it as the alternative recruiting incentive against which the ACF is evaluated. First, because there is more consensus about the enlistment supply effects of pay than other recruiting resources, this approach provides a more solid basis for comparison. Second, from a theoretical perspective, arguments against the cost-effectiveness of the ACF often focus on the assumed inefficiency of an incentive that is both deferred and tied to the consumption of a particular good -- education. Using an immediate cash incentive as the alternative policy for restoring the man-years lost due to an ACF reduction highlights this contrast.

In our baseline case, we assume a pay elasticity of 1.2. That is, a 10% increase in the discounted present value of first-term pay leads to a 12% increase in high-quality enlistments. This is the pay elasticity we estimated in our enlistment supply model (see Appendix A), and it is consistent with recent research in this area.[9]

2.4 Assessing the Change in Costs

Substituting a high-quality enlistment bonus for the current level of ACF benefits will change force-manning costs in two ways. First, the total cost of the ACF will fall both because of fewer ACF enlistments and because the average cost per enlistment will decline under a reduced benefits package. Offsetting this reduction in accession costs to some degree, however, is the increased cost of the enlistment bonus. Second, because ACF enlistments have lower expected man-years, the reduced-ACF option can generate the same number of total man-years with fewer total enlistments. This will reduce the costs associated with training. Our analysis includes estimates of both effects.

Accession Costs. Two accession cost elements are used in the analysis: ACF costs and the cost of the targeted bonus.[10]

9. See Goldberg (1989) for a review of enlistment supply studies.

10. We implicitly assume that other recruiting costs, such as advertising or recruiter support, do not change as the mix of enlistment incentives is altered. Thus, these costs need not be considered in evaluating the change in force-manning costs.

As part of the research underlying this cost-effectiveness study, we estimated the cost of the ACF per eligible accession. Our approach was to (1) estimate a model of the discounted present value of total education benefits usage with the FY82 EBCF, (2) use that model to predict usage for both the FY89 and reduced-benefits versions of the ACF, and (3) determine ACF costs as the share of total usage funded by the program. This methodology is described in Appendix B. Table 3 displays the resulting estimates for the FY89 ACF, along with other recent estimates of ACF costs that are also based on the actual usage patterns of ACF participants.

Note that there is a reasonable concensus among the different estimates for the costs associated with 3- and 4-year accessions. For 2-year estimates, the lower value calculated by the DOD Actuary probably results from an adjustment, made only in that study, for the longer period over which benefits are paid under the New GI Bill as compared with VEAP. Because more attrition from college will occur before all benefits can be received, this adjustment reduces the expected cost of ACF benefits. For the baseline case, we use the Actuary's cost estimates. To test the sensitivity

Table 3. ACF cost estimates*

	Enlistment Term		
Source	2 Years	3 Years	4 Years
Schmitz et al. (1987)	$2,652	$1,618	$1,152
Hogan et al.	---	1,300	---
DOD actuary	1,561	1,342	1,153
Appendix B	2,122	1,184	1,265

*Discounted present value of the per accession cost for the FY89 program.

of the results to ACF costs, we also evaluate cost-effectiveness using our own estimates with the higher costs for 2-year enlistments.

The cost of the targeted bonus required to restore man-years is derived as follows. First, the required increase in non-ACF enlistments is determined by dividing the loss in man-years resulting from reduced ACF benefits by the expected man-years per enlistment for non-ACF soldiers. Second, the proportionate increase in pay required to obtain these enlistments is calculated using the elasticity of high-quality enlistments with respect to pay changes. Third, the proportionate pay change is multiplied by the discounted present value of first-term compensation to find the nominal value of the bonus. Finally, the bonus is weighted by the probability a soldier survives the first six months of service -- the typical point at which enlistment bonuses are paid -- and discounted.

Training Costs. In the baseline case, we assume training costs of $17,000 per accession. This is an inventory-weighted average of basic and advanced individual training costs for the FY89 enlisted force, as derived from the Army Manpower Cost System (AMCOS).[11]

Because ACF enlistments generate fewer man-years on average, it is probably more cost-effective to use the ACF to attract recruits into those skills that have lower training costs. To explore this hypothesis, we also evaluate ACF cost-effectiveness using training costs of $9,000, which is typical of combat arms occupations, and $34,000, which represents the costs of training in technical occupations, such as electronics/communications equipment repair.

Table 4 summarizes the values of the key parameters for the cost-effectiveness analysis. The baseline case is calculated using what we believe to be the most realistic assumptions. To understand the sensitivity of the baseline results to these assumptions, we also evaluate ACF cost-effectiveness by sub. tituting, one at time, the alternative assumptions. Three of the alternative assumptions -- a lower ACF enlistment elasticity, higher ACF costs, and higher training costs -- will reduce the estimated cost-effectiveness of the program. Two assumptions -- smaller ACF retention effects and lower training costs -- will increase the estimated cost-effectiveness. In the next section, we discuss the results.

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11. This probably overstates the average training cost for an *ACF* enlistment because ACF recruits disproportionately enter the combat arms occupations, where training costs are lower. Accurate training costs for the ACF occupations alone could not be obtained because of problems with the Army's occupation-level training data. To the extent we have overstated training costs, we are biasing the results against a finding of cost-effectiveness for the ACF.

Table 4. Parameters for cost-effectiveness analysis

Parameter	Baseline Case	Alternatives
ACF enlistment supply elasticity	.14	.11
ACF effects on reenlistment	-2.7 to -5.5 percentage points	half of baseline assumption
ACF cost per accession	DOD actuary	Appendix B
Training costs	$17,000	$9,000, $34,000
Enlistment pay elasticity	1.2	---

3. RESULTS

Table 5 displays the cost-effectiveness results using the baseline assumptions. The top panel of the table shows the man-years and costs associated with the current ACF program, the second panel presents the estimated man-years and costs resulting from substituting a bonus for reduced ACF benefits, and the bottom panel compares man-years and costs between the policies.

In FY89 there were approximately 15,000 high-quality male soldiers enlisting for 2-, 3-, or 4-year terms who were also eligible for the ACF. This represents about 37% of total enlistments from this group. Given the distribution of ACF enlistments by term of service and the man-year factors in table 2, we estimate that the average ACF enlistment produces 5.22 man-years. This is about 1.5 man-years less than the typical high-quality soldier entering without the ACF; the difference is due to the estimated effect of the ACF on first-term reenlistment rates.[12] Total man-years in line 3 is just the product of enlistments and man-years per enlistment.[13]

In the baseline case the recruiting incentive cost per enlistment for ACF-eligibles is an average of the DOD actuary estimates by term of service (table 3), weighted by the proportion of ACF accessions by enlistment term. The incentive cost for non-ACF accessions is a weighted average of existing enlistment bonus costs by term. Training costs per enlistment are $17,000 for both ACF and other accessions. Total costs are calculated by multiplying the sum of these costs by the number of enlistments.

With a 50% reduction in ACF benefits, we estimate that ACF-eligible enlistments would decline by 3.8% of all high-quality enlistments, or about 1,600 soldiers. The total man-years produced by ACF enlistments go down by proportionately less, however, because lower benefits lead to higher reenlistment rates compared to the FY89 benefits level, and more man-years per ACF enlistment (from 5.22 to 5.37). Altogether, the man-years from ACF enlistments fall by 6,202.

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12. Table D.1 in Appendix D shows the term of service detail underlying the summary numbers presented in table 5.

13. The calculations underlying table 5 use more digits than are reported. Thus, it is not possible to exactly duplicate the computations using the figures reported in table 5.

Table 5. Baseline case results

	ACF Eligibles	Other High Quality
As of FY89		
Man-years:		
1. High-quality male enlistments	15,525	26,094
2. Man-years per enlistment	5.22	6.70
3. Total man-years	81,060	174,718
Costs:		
4. Incentive cost/enlistment ($)	1,380	1,558
5. Training cost/enlistment ($)	17,000	17,000
6. Total costs (M$)	285.4	484.3
With 50% Reduction in ACF		
Man-years:		
7. High-quality male enlistments	13,944	27,020
8. Man-years per enlistment	5.37	6.70
9. Total man-years	74,858	180,920
Costs:		
10. Incentive cost/enlistment ($)	734	2,538
11. Training cost/enlistment ($)	17,000	17,000
12. Total costs (M$)	247.3	527.9
Change (Reduced ACF - FY89)		
13. Man-years	-6202	6202
14. Total costs (M$)	-38.1	43.7

To restore high-quality man-years to the FY89 level, enlistments outside the ACF program have to increase by only 926, or 6,202 divided by the average man-years per non-ACF enlistment, 6.7. Total enlistments are lower under the new policy because the average man-year per enlistment

has increased due to fewer ACF enlistments and longer service among the remaining ACF takers.

Incentive costs per enlistment for both ACF and other enlistments change as a result of the reduction in ACF benefits. With a reduced total benefit offer in the ACF+GI Bill program, we predict lower usage and lower ACF costs -- a drop of approximately 50%. Offsetting this, however, is an increase in the incentive costs for non-ACF enlistments as a result of the larger average bonus required to restore total high-quality man-years.

The bottom line for the baseline case is that substituting a high-quality bonus for reduced ACF benefits, while keeping man-years constant, does *not* reduce force-manning costs. In fact, we estimate that costs would increase by $5.6 million ($43.7M - $38.1M) if this change in policy were implemented. Using the baseline assumptions, then, we find that reducing ACF benefits is *not* cost-effective.

In table 6 we report the bottom-line change in costs using the alternative assumptions about ACF enlistment effects, retention effects, and costs. In line 1, we use the smaller estimate of the

Table 6. Results with alternative assumptions

Alternative Assumption*	Change in Costs with ACF Cut (M$)
1. ACF enlistment supply elasticity = .11	-1.4
2. Smaller ACF effects on reenlistment	+13.0
3. Higher ACF costs per enlistment	+4.2
4. Training costs = $9K	+10.9
Training costs = $34K	-5.5

*Other than the alternative listed, baseline case assumptions are used.

effect of ACF benefits on enlistment supply and find that a reduced-benefits program would be cost-effective. However, we estimate the savings would be less than $1.5 million. The baseline results are sensitive to the assumed relationship between education benefits and reenlistment rates. If the retention effects are smaller, as assumed in line 2, costs would increase substantially with a reduced-

benefits ACF. Finally, because of the relatively small number of 2-year enlistments, the variation in ACF costs for these enlistments has only a small effect on estimated costs (line 3). Taken together, these results confirm the cost-effectiveness finding from the baseline case. Within what we believe are realistic ranges for the key parameters in the analysis, reducing the benefits levels of the Army College Fund would *not* provide significant savings in incentive and training costs for the Army.

Varying the training cost assumption confirms that, in our analysis, the ACF becomes less cost-effective as training costs rise. If the average training cost were $9,000 instead of $17,000, we estimate that reducing ACF benefits would increase force-manning costs by $10.9 million. On the other hand, with training costs of $34,000, the analysis indicates savings of $5.5 million with a reduced-benefit ACF. These results suggest that targeting the ACF to low-training-cost occupations may be advantageous, provided, however, that ACF enlistment supply effects do not vary significantly by occupation.[14]

14. If increases in ACF benefit levels induced disproportionately more enlistments in high-cost occupations, the savings cited for $34,000 training costs would be smaller.

4. SUMMARY

In this report we have examined the cost-effectiveness of the ACF in comparison to a targeted cash incentive. Combining new research results with existing evidence, we defined reasonable ranges for the key parameters and evaluated the ACF over these ranges. We found that reducing the ACF from its FY89 benefit levels is *not* a cost-effective policy change. This finding supports the continued use of the ACF at present levels in meeting the Army's high-quality recruiting mission.

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PART II

TECHNICAL APPENDICES

APPENDIX A

ARMY COLLEGE FUND EFFECTS ON ENLISTMENT SUPPLY[1]

A.1 INTRODUCTION

The Army and the other services offer postservice education benefits to enlistees as a recruitment incentive.[2] This study estimates the effects of the Army's education benefits program on the supply of Army enlistments. It measures the effects of the program on the supply of nonprior service, high school Graduate or Senior, Male, test score category I-III A enlistments (GSMAs). In addition, the study estimates the effects on GSMAs of military pay, enlistment bonuses, recruiters, national advertising, and other factors.

The U.S. Army Recruiting Command is organized administratively into 55 districts known as "battalions." Estimates of the effects of supply factors are obtained using regression analysis, with an extensive monthly battalion-level database that includes observations for FY1981-89. The study is unique in the use of an exceptionally large sample (5,184 observations), and in the development of new or improved measures of variables for education benefits, bonuses, civilian pay, and population.

Section A.2 presents a theory of enlistment supply to provide a basis for specifying the regression model. The model is specified in Section A.3, which also discusses estimation and validation procedures. Results are presented in Section A.4; a summary and conclusions are given in Section A.5.

Supplementary materials are included in the final four sections. Section A.6 provides annual trends in the regression model variables. Estimates of the model using alternative measures of civilian earnings variables are reported in Section A.7.

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1. Economic Research Laboratory conducted and documented the research described in this Appendix.

2. For estimates of the present value of education benefits programs offered by the services since 1977, see Goldberg et al. (August 1986).

Civilian pay is an important explanatory variable in the econometric model. Previous enlistment supply studies indicate that the variable should be constructed with data on youth earnings, but monthly battalion-level data are not available.[3] The data problem is overcome by estimating a youth earnings forecasting model with annual state-level data for the period 1977-87. The model is presented in Section A.8, as well as details on how we used the results to construct the monthly battalion-level pay series.

Previous studies by RAND indicate that bonuses increase the term of enlistment (TOE) selected by enlistees. Education benefits are likely to reduce the term selected because enlistees are eager to use the postservice education benefit. To test this hypothesis and the previous findings, Section A.9 analyzes the effects of ACF benefits and bonuses on the TOE distribution. The remainder of this introductory section provides background information on the Army's education benefits and enlistment bonus programs.

A.1.1 Background Information on Army Education Benefits and Bonus Programs

The Army's education benefits program has varied over the period FY1981-89 (table A.1). Table A.1 gives trends in the present value of education benefits, evaluated using a 30% discount factor, by TOE. The calculations assume that the enlistee collects the maximum benefits offered by the program. A weighted average across TOEs is calculated: the table shows that benefits have been increasing steadily in the 1980s from $1,161 in 1980 to $4,204 in 1989.

Table A.1 also reports trends in the percent of Military Occupation Specialties (MOSs) included in the program. MOSs are weighted by their relative importance in terms of accessions in FY1981-89 to estimate the percentage of jobs included in the program. Program coverage steadily increased in the 1980s except for a decline late in the decade due to congressional budget cuts.

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3. For a review of the Army enlistment supply literature, see Goldberg et al. (August 1989).

Table A.1. Present value (PV) and MOS coverage of Army education benefits

Program/Period	PV of Benefits ($) TOE 2	TOE 3	TOE 4	All	MOS Coverage (%)
EITP,[a] PHASE II 12/79-11/80	1,547	1,215	1,022	1,161	41.6
EATP[b] 12/80-09/81	2,602	2,183	1,799	2,057	59.7
ACF I 10/81-09/84	4,144	3,187	2,122	2,821	71.2
ACF II[c] 10/84-06/85	4,565	3,187	3,275	3,328	78.1
NEW GI BILL 07/85-09/89[d]	4,900	4,593	3,592	4,204	63.0

a. Educational Incentive Test Program.
b. Weighted average of the four test cells in the Educational Assistance Test Program.
c. Weighted average of the basic program for those with no college credit and for those who had already earned 60 or more college credits.
d. There have been minor changes in the program since 07/85-09/89. These are not presented for simplicity of exposition.

A test of education benefits programs offered by the services was undertaken in December 1980, i.e., the Educational Assistance Test Program. Enlistees in hard-to-fill MOSs were offered expanded benefits compared to the existing Veterans Education Assistance Program (SuperVEAP). One of the test programs, called UltraVEAP, provided substantial "kickers" to qualified enlistees. In October 1981 the program was introduced nationally and it became known as the Army College Fund (ACF). There have been other changes since then: benefits for 2- and 4-year enlistees were expanded in October 1984; in July 1985 the "New GI Bill" was introduced which further increased benefits (Goldberg et al., August 1986).

In most previous studies, the effect of education benefits on enlistment supply has been measured with a dummy variable equal to one for the observations in which the program was available. Because benefits have varied over time, this approach is inadequate for measuring the

effects beyond the test period, December 1980 - September 1981. In recent studies researchers have developed continuous variables that measure changes in benefits over time. In particular, Kearl, Horne and Gilroy (1990) estimate an Army enlistment supply model with an education benefits variable reflecting both the level and coverage of benefits.

Like ACF benefits, bonuses are available to GSMA enlistments who select hard-to-fill MOSs.[4] Bonuses have varied in amount and MOS coverage over the period FY1981-89 (table A.2). In particular, a bonus effectiveness experiment was undertaken in July 1982-June 1984. In comparison to a control cell, two programs were tested that increased bonuses (but not coverage). The first test program (EBT8K) provided to an $8,000 bonus for 4-*year* enlistees as compared to $5,000 previously available. In addition to the $8,000 bonus for 4-year enlistees, the second test program (EBT84K) provided a $4,000 bonus for qualified *3-year* enlistees.[5]

Table A.2. The Army Enlistment Bonus Program: Average bonus per recipient and MOS coverage by TOE

Period	Average Bonus ($) TOE 3	Average Bonus ($) TOE 4	Coverage (%) TOE 3	Coverage (%) TOE 4
10/80-09/81	0	3,726	0.0	25.9
10/81-06/82	0	4,204	0.0	40.8
07/82-06/84	3,962	4,489	4.1*	50.4
07/84-09/84	4,000	3,990	25.4	65.7
10/84-09/85	3,963	4,330	24.0	68.2
10/85-09/86	3,681	4,215	28.2	69.8
10/86-09/87	2,981	3,100	25.5	40.5
10/87-09/88	3,310	2,759	20.2	49.1
10/88-09/89	3,636	3,379	21.3	64.8

* Coverage was 4.1% nationally. It was approximately 24% in the EBT84K test cell which included 16% of the country.

4. The eligible MOSs were not the same for the two programs.

5. Soldiers must enlist for an initial term of three years plus the length of training in their MOS.

In July 1984 the bonus program was sharply expanded to include all recruiting battalions, and bonuses were offered to 3-year enlistees in selected MOSs. An $8,000 bonus for 4-year enlistees was also offered for a handful of MOSs. The program has not been constant since then. Bonuses declined starting in FY86 and then increased in FY89. For 3-year enlistees, program coverage peaked in FY86; it has steadily declined since then. For 4-year enlistees, coverage has fluctuated sharply in the late 1980s.

In most previous studies researchers have attempted to measure the effects of bonuses with dummy variables that reflect whether the first or second test program was in effect. This approach is appropriate only for observations in the base and test period, i.e., July 1981-June 1984. Given the variability of the program, continuous measures are needed to take into account changes in bonus levels and program coverage.

A.1.2 Previous Estimates of the Effects of ACF Benefits and Bonuses

The Education Assistance Test Program was analyzed in a RAND study by Fernandez (1982). The effect of the UltraVEAP dummy variable on the logarithm of GSMA enlistments was estimated to be 0.087; this translates into a 9.1% increase in GSMA enlistments as compared with SuperVEAP. Most other studies that use a dummy variable to measure the effects of the implementation of UltraVEAP, e.g., Daula and Smith (1985) and Goldberg et al. (1987), also estimate about a 9% effect. Exceptions are studies by Fairchild et al. (1984) and Goldberg et al. (May 1986), which estimate larger effects of 28% and 21% respectively. These findings are probably biased upward due to the omission of critical variables. Given the change in GI Bill benefits (ACF over SuperVEAP) of 83% the estimate of 9% implies an education benefits elasticity of .11 (9+83).[6]

6. The estimate of an 83% increase in benefits is based on data given in table A.1. It is the difference between ACF I benefits and EITP, Phase II (SuperVEAP) divided by the average benefits for the two programs.

Estimates of GI Bill benefits elasticities based on continuous measures range from 0.04 to 0.11, if one excludes the high estimates of 0.23 (Goldberg et al. November 1986) and 0.42 (Warner, 1987), which may be spurious because of collinearity. The lower estimates from Dale and Gilroy (1984), Gilroy et al. (1990), and Kearl et al. (1989), average about 0.08, close to the estimates obtained using dummy variables.

In summary, most studies find a statistically significant but relatively small effect of ACF benefits on enlistment supply. Estimates vary because of differences in the ACF variable, the sample period, and the units of observation utilized to obtain estimates. They also vary because of specific measurement problems.

The Bonus Effectiveness Experiment was evaluated in a RAND study by Dertouzos and Polich (1989). They estimated the coefficient of the EBT8K test cell to be just 0.008 and not significant; for the EBT84K test cell, they estimated a small but statistically significant effect of 0.048. The low and insignificant effect for test cell EBT8K and the positive effect for EBT84K imply that supply was not increased by increasing bonuses for 4-year enlistments; but, rather, it was expanded because bonuses were offered for the 3-year TOE. Using detailed regional-level data, Dertouzos and Polich also obtained baseline elasticities of Army advertising: for national, 0.02; for local, 0.005.[7]

This study will construct continuous measures of education benefits and bonuses that take into account changes in the level of the benefits and coverage of the programs. The variables will be used to estimate the effects of the programs on GSMA enlistments.

A.2 THEORY OF GSMA ENLISTMENT SUPPLY

A model of GSMA enlistment supply is derived in this section. The derivation involves three parts. First, we develop a model of enlistment for the individual based on the economic theory of occupational choice. Then, by including the *eligible* population, the model is specified for regions

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7. Only the short-run effects are reported here. For discussion of the methodology and estimates of the long-run effects, see Dertouzos and Polich (1989).

and extended to include enlistment standards. Finally, by making the decision to enlist a function of the information available to the population, the theory is generalized to include recruiters, goals, advertising, and other variables.

A.2.1 Enlistment Model for an Individual

An individual is assumed to choose a sequence of jobs that provides him with the greatest satisfaction over his lifetime. He ranks jobs based upon the current and future expected net benefits, both pecuniary and nonpecuniary. The latter includes not only working conditions but also the intrinsic satisfaction that the job may provide.[8]

The decision to enlist in the Army fits quite well into an occupational choice framework. We define $U_{Army}(A, J_A)$ as the expected utility of a sequence of jobs that includes Army enlistment, A, and postservice employment, J_A.[9]

$U_{Civilian}(C, J_C)$ is the utility associated with an alternative sequence of jobs. It includes pursuing a civilian alternative, C, over the enlistment period, and then an optimal sequence of jobs, J_C. An individual will enlist if the utility of Army enlistment is greater than that of the civilian alternative; or

$$U_{Army}(A, J_A) > U_{Civilian}(C, J_C) \tag{1}$$

Specific arguments in $U_{Army}(\ldots)$ include factors such as pay, term of enlistment, education benefits, bonuses, and future job opportunities. A change in a factor, pecuniary or nonpecuniary, that increases the benefits of enlistment relative to the alternative increases the utility of enlistment.

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8. This is especially important in the case of military service. Patriotism -- the desire to serve one's country -- undoubtedly contributes to many decisions to enlist in the Armed Forces.

9. Jobs are defined broadly to include "other activities," recognizing that some individuals may find it optimal to invest in additional education or training, or to enjoy leisure rather than employment.

We do not actually observe the "utility function" -- only some of its determinants. Given that there are unobservable factors, we cannot say for sure that a specific individual will enlist if the benefits of enlistment increase; however, one can say that the probability of enlistment increases as benefits rise. Consequently, we specify the decision to enlist for an individual as a probability model and approximate it using a loglinear equation,[10]

(2) $$\ln P = a_1 \ln Z + a_2 \ln X_A + a_3 \ln X_C + u,$$

where P is the probability of enlistment, X_A and X_C are vectors describing the observed attributes of Army enlistment and the alternative, Z is a vector of observable characteristics of the individual affecting "tastes," and u is the net effect of unobservable factors.

A.2.2 Aggregate Model for a Region

The probability that an eligible individual enlists is given by

(3) $$P = Z^{a1} X_A^{a2} X_C^{a3} e^u$$

The expected number of enlistments, E, in a region will depend upon P and the eligible population pool, POP:

(4) $$E = POPZ^{a1} X_A^{a2} X_C^{a3} e^u$$

This yields an aggregate enlistment supply equation that is also linear in logs:

(5) $$\ln E = \ln PoP + a_1 \ln Z + a_2 \ln X_A + a_3 \ln X_C + u$$

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10. While most researchers assume a loglinear specification, semilog and logit models also are a possibility. The critical requirement is that the functional form permit diminishing effects of factors on the probability of enlistment.

Policies affecting eligibility are used by the services to influence enlistment supply. To include a policy change -- say, limiting eligibility -- one could reduce the eligible population pool by the number who are excluded. This requires detailed information on the population pool. Instead, researchers have typically included a measure of the policy change explicitly in equation (5).[11]

A.2.3 Information and Recruiting Effort Variables

An individual chooses an alternative based on the information available about the choices. Consequently, we expand the model to include variables that provide information regarding an Army enlistment and its alternatives. Let INF be an index of information available to the individual. Then the probability of its enlistment for an individual is a function of INF.

Information is produced by recruiters, advertising, and other factors. We assume a loglinear relationship between INF and these factors,

$$\text{(6)} \qquad INF = e^{a_0} X_i^{a_4}$$

where X_i is a vector of variables that produce information, such as Army recruiters and advertising. We expect INF to be a positive function of Army information variables and a negative function of other information variables, *although complementary of some information* variables is also a possibility.

So far we have discussed a generic enlistment model, but our objective is to derive a model of supply for GSMA enlistments. We must modify the model to take into account information targeted on the GSMA population by recruiters as a result of their efforts. The recruiter is assigned a mission for GSMA enlistments and other cohorts, i.e., nongraduates, females, etc. The level of information targeted on the GSMA population will be a positive function of the GSMA mission assigned to recruiters, and a negative function of the non-GSMA mission. It will also depend upon

11. For example, see the Air Force enlistment supply model in Goldberg and Goldberg (1988).

the relative importance to the recruiter of achieving each mission assigned. These factors are added to the set of information variables X_I.

Revising the aggregate model to a reflect the information provided to a potential GSMA recruit, we obtain:

$$\text{(7)} \qquad \ln(E/POP) = a_0 + a_1 \ln Z + a_2 \ln X_A + a_3 \ln X_C + a_4 \ln X_I + u$$

This is a typical model of GSMA enlistment supply found in the literature: the logarithm of enlistments per population is specified to be a loglinear function of explanatory variables. The models typically include the ratio of military to civilian earnings (relative pay), unemployment, recruiters, and other factors. Most models are estimated with aggregate data. Characteristics affecting tastes are usually assumed to be constant across observations so that "Z variables" are excluded. Instead, researchers include demographic and policy variables to adjust for differences in eligibility; they also include goals and policies affecting GSMA recruiting effort.

We have derived an aggregate GSMA enlistment supply model from the theory of occupational choice. Within this model we have provided a rationale for including not only the characteristics of Army enlistment that directly affect one's satisfaction, such as pay and benefits, but other variables that have been found to affect the supply of enlistments, such as recruiters, goals, advertising, and policy changes. Next we specify an econometric model for estimating the effects of supply factors on GSMA enlistments.

A.3 SPECIFICATION AND ESTIMATION OF A GSMA ENLISTMENT MODEL

A.3.1 Econometric Model Specification

Following the aggregate supply model, we divide variables into three different types: those associated with the attributes of Army enlistment and the civilian alternative, X_A and X_C; those associated with the production of information, X_I; and those associated with population and eligibility.

The econometric model includes continuous (X_i) and dummy (D_j) variables:

$$\text{(8)} \qquad GSMA = \Sigma\pi_i X_i + \Sigma\beta_j D_j + \epsilon_i$$

where GSMA = logarithm of gross contracts for GSMA enlistments per qualified military available (QMA),

X_i = logarithm of supply factors,

D_j = dummy variables, and

ϵ_i = random error term.

The regression coefficients of continuous variables are "partial elasticities," i.e., the percentage change in enlistments due to a supply factor increasing by one percent, holding all other factors fixed. In equation (8), the coefficient of a dummy variable measures the percentage change in enlistment supply resulting from an increase in the variable from zero to one.

The loglinear functional form permits the effects of supply factors, such as recruiters, to exhibit diminishing marginal returns. It assumes, quite reasonably, that the productivity of recruiters is affected by the levels of other factors, such as relative military pay. Thus, as relative military pay increases, the productivity of recruiters is assumed to increase.

Figures A.1 and A.2 provide the definition, data source, and expected sign for the explanatory variables used in the model. The variables associated with attributes of the Army and civilian alternatives are relative military pay (MILPAY), unemployment (UNEMP), education benefits (ACF, ACFPV, ACFCOV), and bonuses (BON3, BON3SQ, BUYUP). Information and recruiting effort variables are recruiters (RECR), advertising (ADV), goals (GOAL, GOALNOTA), and policies (POL86). Variables associated with eligibility and population are Qualified Military Available (QMA) and Military Available (MA). Trends in these variables are shown in Section A.6.

A.3.2 Army and Civilian Alternative Variables

Previous studies have found that two of the most important factors affecting enlistments are relative military pay and unemployment. These factors are included and are expected to have positive effects.

MILPAY	=	(logarithm of) present value (at 30% discounted factor) of Basic Military Compensation (BMC) during a 4-year enlistment divided by the present value (at 30% discount factor) of earnings for 18- to 21-year-old civilian males (CIVEARN); each series is a five-month average centered on the current month. (+) BMC includes base pay as well as the allowances for housing and food, and the tax advantage of the allowances. The calculation of BMC assumes the average time-in-grade for Army enlistees and that the enlistee is unmarried during his or her term of service. (Source: OSD/Compensation.) CIVEARN is constructed with FY1979 data from the 1980 Census on youth earnings, aged using a local area forecasting model. (Sources: 1980 Census; BLS Employment and Earnings, 08/80-09/89; and *Current Population Surveys*, 1978-88.)
UNEMP	=	(logarithm of) civilian unemployment rate, five-month moving average centered on the current month. (Source: BLS, *Employment and Earnings*, 08/80-09/89.) (+)
ACF	=	(logarithm of) weighted average summed across TOEs of the present value of the maximum education benefits available to Army enlistees (ACFPV), times ACF program coverage (ACFCOV) divided by a cost-of-college price index -- sum of tuition (four-year state university) plus room and board. (Sources: Army DCSPER, USAREC, Department of Education.) (+)
BON3	=	for only TOE 3, bonus per taker times bonus program coverage, divided by the present value of civilian earnings of youth (CIVEARN). (Sources: Army DCSPER, USAREC, CPS.) (+)
BON3SQ	=	BON3 squared. (-)[a]
BUYUP	=	binary variable measuring the effects of the Bonus Buyup Program; equal to 1.0 in June 1987 - September 1989 and 0.0 otherwise. (+)

a. Negative sign expected because of diminishing returns.

Figure A.1. Army and civilian alternative variables used in the GSMA models

Relative military pay is the ratio of the present value of Basic Military Compensation (BMC) for a typical enlistee over a 4-year enlistment period, divided by the present value of full-time equivalent earnings of 18- to 21-year-old males. (Data on military pay and promotion rates were obtained from the Office of Military Compensation, OSD.)

Using Census microdata, Princeton University Computing Center provided us with calculations of average earnings by battalion. The sample was restricted to civilians (noninstitutionalized) youth who were working during 1979 for (usually) 35 or more hours per week.

Weekly averages were calculated for two groups: 16- to 19-year-old and 20- to 24-year-old males. An implicit growth rate of earnings was calculated from these two endpoints, and four-year streams were estimated (i.e., for approximately 18-, 19-, 20-, and 21-year-olds) by battalion. To age the 1979 battalion-level cross-section, we used a youth earnings forecasting model estimated with state-level data for 1977-87 (see Section A.8).

RECR	=	(logarithm of) Army production recruiters assigned zero, half, or full missions per QMA. (Source: USAREC.) (+)
GOALA	=	(logarithm of) net missions for GSMA enlistments per QMA. (Source: USAREC.) (+)
GOALNOTA	=	(logarithm of) net missions for non-GSMA enlistments per QMA. (Source: USAREC.) (-)
POL86	=	binary variable measuring the effect of the reinstitution of the Mission Box in FY86 and increased emphasis on the achievement of the GSMA mission; equal to 1.0 in FY1986-89 and 0.0 otherwise. (+)
ADV	=	(logarithm of) sum of monthly placement expenditures for national print, radio, and TV advertising, each adjusted for inflation using separate media cost price indexes. (Sources: USAREC and McCann Erickson.) (+)
QMA	=	(logarithm of) 17- to 21-year-old male, qualified military available population, 13-month moving average centered on the current month. (Source: ERL.)
MA	=	(logarithm of) 17- to 21-year-old male high school graduate population, 13-month moving average centered on the current month. (Source: Woods & Poole.)

Figure A.2. Information, recruiting effort and population variables used in the GSMA models

Monthly unemployment data are available by state and Metropolitan Statistical Area (MSA) from the Bureau of Labor Statistics (BLS). They are overall (youth and adult) unemployment prepared by state employment service agencies from establishment sources according to BLS procedures. BLS regularly reconciles these figures with Census and Current Population Survey (CPS) estimates. We aggregated the state and MSA-level data to yield monthly battalion-level observations.

Army College Fund (ACF) benefits can be viewed as consisting of two major components: the present value of benefits divided by a cost-of-college index (ACFPV), and the MOS coverage of the program (ACFCOV). ACFPV is the same for each MOS; it includes both the present value of basic education benefits and ACF "kickers." For each MOS, ACFCOV equals 0 (MOS excluded) or 1 (MOS included) weighted by the percentage of nonprior service (NPS) male accessions in the MOS in FY1981-89.[12]

USAREC provided national monthly-level data on the ACF program by MOS based on an examination of individual-level records for FY1981-89. The individual-level data were used to determine which MOSs were eligible for benefits. If benefits were available to one individual in a given MOS, it was assumed to be available to all individuals choosing the MOS that month. The coverage of the program was estimated using this information.

We sum the data at the MOS level by TOE to construct observations for ACFPV, ACFCOV, and "ACF" (ACFPV times ACFCOV). A weighted average across terms of enlistment is calculated. TOE weights are equal to the average percentage of NPS male accessions in FY1981-89.[13] In the estimation we consider models with alternative ACF variables.

As noted earlier, a previous study by RAND evaluated the Enlistment Bonus Experiment undertaken in July 1982-June 1984. RAND found that only bonuses for 3-year enlistments increased GSMA supply and that the effect was relatively small, i.e., 0.048 (Dertouzos and Polich, 1989). As a result, we construct a bonus variable for just the three-year program element (BON3).

Like the variable ACF, BON3 is a weighted sum across MOSs of average bonus per recipient and program coverage. The deflator, however, is the present value of civilian earnings (CIVEARN) rather than a cost-of-college index, and the summation is only across the three-year

12. Most of the basic data used to calculate ACF variables are developed at the MOS level by TOE. The weights are defined at the MOS level without regard to TOE.

13. TOE weights in percents are 7.6 for TOE 2, 51.2 for TOE 3, and 41.2 for TOE 4 or greater.

program element. Data on MOS coverage and bonus per recipient were obtained from the Army's DCSPER for FY1981-87, and from USAREC for FY1988-89.[14]

Bonuses for a 3-year enlistment were not available prior to the Enlistment Bonus Experiment; therefore, we cannot use a logarithmic specification for the variable. Instead, we include two terms, BON3 and BON3 squared (BON3SQ); this is done to permit diminishing returns to increases in bonuses.

In June 1987 the Army implemented the Bonus Buyup Program (also known as the Enhanced Bonus Program). It remained in effect until September 1989, generally increasing in payoff and coverage until its termination. The primary purpose of the program was to increase enlistment terms. A bonus was offered for each year above four on the enlistment contract -- specifically, $1,000 during June-October 1987 and, $1,500 during November 1987-September 1989. Initially, it was available only for selected MOSs already offering bonuses. In June 1988 coverage was expanded to include MOSs that did not offer a bonus for a 3- or 4-year enlistment. We include a dummy variable to measure the effect of the Bonus Buyup Program.

A.3.3 Information and Recruiting Effort Variables

Recruiting effort is measured by the number of production recruiters (RECR) per QMA and two goal variables -- GSMA mission per QMA (GOALA) and non-GSMA mission per QMA (GOALNOTA). Also included is aggregate national advertising expenditures (ADV). Ideally, one would like to measure the number of "impressions" by each media type per population. But because, these data are not available, we use advertising expenditures as a proxy for impressions per QMA. We expect that recruiters, GSMA mission, and advertising will have a positive effect on supply. By diverting recruiting effort to other groups, increases in the non-GSMA mission should have a negative effect on GSMA enlistments.[15]

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14. Data on the geographical definition of the education benefits and bonus test cells were obtained from USAREC. These were used to construct the measures of the variables.

15. Treatment of mission variables is complex and to some degree controversial. For interesting earlier studies, see Daula and Smith (1985), Dertouzos (1984), Goldberg and Goldberg (1988) and John and Shugart (1976).

In FY86 USAREC reinstated the "Mission Box," which provided detailed goals to recruiters by enlistment category; achievement of the GSMA mission was emphasized above all the others. This had a strong positive effect on GSMA production. We include a binary variable, POL86, to measure the effect.

A.3.4 Eligibility, Population, and Seasonal Variables

While not strictly an "information" variable, the size of the population pool affects the likelihood that an individual will be provided information by a recruiter. It is usually assumed that the supply equation is "linear homogeneous" with respect to population; that is, holding all supply factors constant, including information variables per population, an increase in the population of Y% will result in a Y% increase in the supply of enlistments.

We consider two measures of population: Military Available (MA) and Qualified Military Available (QMA). The MA measure is simply the population of 17- to 21-year-old male high school graduates (HSGs). Annual county-level data were obtained from Woods and Poole for 1980-90.[16]

The QMA measure is constructed using a local area forecasting model developed in a previous study by ERL Goldberg and Goldberg (1989). It adjusts estimates of the 17- to 21-year-old male HSG population for regional differences in mental, physical, and moral qualification. Local area explanatory factors in the QMA model are the poverty status and school achievement of the general population, and the racial mix of the HSG population. Data on poverty status and school achievement at the county level were obtained from the 1980 Census. These were used to estimate MA to QMA conversion factors for each battalion. The conversion factors were essentially invariant over time. As a result, for a given battalion changes in QMA over time are a function of changes in the MA population.

Besides the variables given in figures A.1 and A.2, we include monthly dummy variables to adjust for "seasonality" of enlistments due to school attendance by high school seniors.

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16. Source: Woods and Pool Economics Inc., Washington, D.C., September 1989.

Before turning to estimation procedures, we discuss a data problem that affects the sample. While the number of battalions was fairly constant over the sample period (55/56), there were numerous boundary changes. Fortunately, the major shifts were confined to the area within 11 battalions. To construct a consistent data set, we created four mega-battalions with constant boundaries from the 11 that traded territory over the sample period. Thus, the data set consists of 48 "battalions" over 108 months, a total of 5,184 observations.

A.3.5 Estimation Procedures

In pooling data, we assume that enlistment equations for each battalion are identical. But differences among battalions in their economic structures, recruiting organizations, and populations' attitudes toward the military make this assumption of identical functions highly tenuous. If one uses the ordinary least squares (OLS) procedure to estimate the model, specification errors are likely to result in autocorrelated residuals, and biased estimates of factors that are themselves autocorrelated.

Another source of bias pertains to recruiters: they are distributed in accordance with their expected productivities. "Simultaneity bias" is the result, which causes one to overestimate the recruiter elasticity. A similar problem exists for the goal variables.

To overcome these problems, we estimate the model using the fixed effects (FE) procedure Maddala (1977). The FE technique has been used successfully in previous enlistment studies Daula and Smith (1985), Goldberg and Goldberg (1988), and others that estimate models with time-series/cross-section data.

To assess the model, we review the coefficients for plausibility and conduct out-of-sample forecasting tests. To provide an indication of the overall fit of the model, we report the standard errors of the estimates (SEEs) and the adjusted R^2, (R BAR SQ). We also thoroughly analyze the residuals (r_t) for evidence of specification errors.

The residuals are tested for autocorrelation by regressing r_t on r_{t-1}, estimating "RHO" the autocorrelation coefficient:

(9) $r_t = (\text{RHO})r_{t-1}$ + error term

The Durbin-Watson (DW) statistic is approximately equal to 2(1-RHO). We use the approximation of the DW to test the hypothesis of first-order autocorrelation. At the 5% level, significance points are $d_L = 1.57$ and $d_U = 1.78$, Maddala (1977). To determine whether important variables are omitted, we calculate the errors of the aggregate within-sample predictions by fiscal year.

In addition to analyzing within sample prediction errors, we undertake beyond-sample forecasting tests for FY89. The models are estimated with data for the period, FY1981-88, and the results are used to generate national and battalion-level forecasts for FY89. We also undertake an extensive error composition analysis through estimation of the equation

(10) $\text{Actual}(89) = A_0 + A_1\text{Prediction}(89) + \text{error}$

If the model forecasts accurately, then A_0 should equal zero, A_1 should equal 1.0, and the error should be relatively small. The forecasting errors can be analyzed and decomposed to reveal the percent that is systematic (mean bias plus regression error) and the percent that is random, Intriligator (1978). A large systematic component indicates the presence of specification errors. We calculate the error decomposition percentages for the components to assess whether there are specification errors in the forecast period.

We found that the residuals in the fixed effects model were autocorrelated. To address this problem, we transformed the data using the estimate of RHO, and reestimated the model. The coefficient estimates were not affected. Since our primary objective is to obtain unbiased estimates of the effects of ACF benefits, we report only the results obtained using the FE procedure. This permits us to focus on the specification of the model rather than on the estimation procedure.

In the next section we report estimates of the FE models, which contain alternative measures of ACF benefits and bonuses.

A.4 RESULTS

In preliminary analysis we considered models with the following alternative measures: ACF benefits (ACF versus ACFPV and ACFCOV); relative military pay (military pay deflated by civilian earnings of youth versus wages of all workers); and population (QMA versus MA). We found that earnings of youth was a better measure of civilian pay (see Section A.7).

The results were insensitive to the measure of population. The reason for this finding is that the FE technique uses only the time-series variation in the data to estimate the models, and this is essentially the same for the two measures, QMA and MA. We also included the logarithm of QMA as an additional explanatory variable to test the homogeneity assumption. The coefficient of the QMA variable was very small and not statistically significant. Therefore, it was dropped.

We found that dummies for the months of October, November, and December were not significant, and that some of the months could be combined because the effects were the same. The final specification includes the following seasonals: M1 (January); M2 (February, March, September); M5 (May); M6 (June, August); and M7 (July). The results for the seasonals are not reported to simplify the tables and the discussion.

In table A.3 we report FE estimates and forecasting tests for two models that include alternative ACF variables. Model 1 contains ACF; Model 2 contains ACFPV and ACFCOV.

A.4.1 Coefficient Estimates

All of the variables have the expected sign, and the estimates are relatively stable across the two models. With the possible exception of recruiters, the coefficients are similar in magnitude to those obtained in previous studies. Because of the large sample, the confidence intervals are exceptionally small. This enables us to obtain more precise estimates than in previous studies.

Table A.3. Estimates of GSMA Enlistment Models (continued on next page)

	Model 1		Model 2	
Variables	Coeff.	t-Stat.	Coeff.	t-Stat.
MILPAY	1.20	11.26	1.18	11.06
UNEMP	0.59	32.33	0.60	32.58
GOALA	0.28	28.26	0.27	26.94
GOALNOTA	-0.09	8.37	-0.09	8.67
RECR	0.15	4.76	0.14	4.58
ADV	0.05	8.55	0.05	8.83
ACF	0.14	10.51	--	--
ACFPV	--	--	0.11	6.92
ACFCOV	--	--	0.23	8.69
BON3Q	4.3	23.10	5.54	3.89
BON3SQ	-84.22	1.87	-139.12	2.95
BUYUP	0.06	5.73	0.07	6.08
POL86	0.20	21.33	0.21	20.85

	Within-Sample Summary Statistics	
	Model 1	Model 2
OBS	5,184	5,184
DF	5,120	5,119
RBARSQ	0.717	0.717
SEE	0.178	0.178
RHO	0.34	0.34
DW	1.32	1.32

Table A.3. (concluded)

	Within-Sample Prediction Errors (%)* Model 1	Model 2
FY82	3.84	3.10
FY83	-4.82	-4.80
FY84	3.19	4.16
FY85	-1.82	-1.92
FY86	-0.26	0.34
FY87	-0.14	-1.08
FY88	-1.68	-2.36
FY89	3.31	4.28
Out-of-sample Forecasting Tests for FY89		
FORECAST	53,912	56,083
ACTUAL	50,437	50,437
ERROR	3,475	5,646
% ERROR	6.89	11.19
RMSE (%)	0.245	0.272
Error Composition Analysis Actual = A_0 + A_1 Prediction + Error		
MEAN BIAS	0.103	0.233
REGRESSION	0.112	0.115
RANDOM	0.785	0.652
A_0	6.12	5.84
STD ER A_0	1.29	1.29
A1	0.87	0.84
STD ER A1	0.012	0.011
R BAR SQ	0.903	0.904
SEE	15.72	15.66

* Error = (Actual-Predicted)/Actualx100

Pay and unemployment have large positive effects on GSMA enlistments. In Model 1 the elasticity for pay is 1.20; for unemployment, it is 0.59. In previous studies using youth earnings as a measure of civilian pay, the average estimate of the pay elasticity is 1.60. The average estimate of the unemployment elasticity obtained in previous studies is 0.68 (Goldberg et al., August 1989).

The *total* effect of recruiters is the effect of increasing recruiters *and* missions. To obtain an estimate, we sum the coefficients for the RECR, GOALA, and GOALNOTA variables. The estimate of the total effect is about 0.33 in the two models. This estimate is about half the size of that obtained in previous studies, i.e., 0.67 (Goldberg et al., August 1989).

The elasticity for national advertising is 0.05 in both models. This is about twice the size of the estimate obtained by RAND (0.023) in a recent study using detailed monthly battalion-level data, Dertouzos and Polich (1989).

In Model 1 the elasticity of the ACF variable is 0.14. In Model 2 the ACFPV and ACFCOV variables have coefficients which are statistically different from each other. Holding coverage fixed, the elasticity of benefits is 0.11. If benefits are held fixed and coverage is increased (to include more desirable MOSs), GSMA supply increases. The elasticity is much larger -- 0.23.

The findings are generally consistent with those obtained in previous studies. As noted, RAND found that the UltraVEAP increased GSMA enlistments by 9.1% over SuperVEAP[16] Fernandez (1982). In the RAND study benefits were increased but coverage was held fixed. Using the elasticity of ACFPV obtained in Model 2 (0.11) and the change in the logarithm of ACFPV between the two test cells (0.83), we estimate an effect of 9.1% as well.

Estimates of the effects of BON3 and BON3SQ terms yield results similar to those obtained by RAND. The bonus program for 3-year enlistments increased dramatically in July 1984 after the Enlistment Bonus Experiment was completed. We estimate a *total* effect of "going national" in July 1984 to be 5.5% for Model 1 and 4.8% for Model 2. The estimates are derived by evaluating the

16. In the same study, RAND found no increase in enlistments when ACF coverage was expanded. The relative small change in coverage observed during the EATP may be the cause of this counter intuitive result.

model at the July 1984 value of the variables BON3 and BON3SQ, i.e., BON3 equal to 0.0273, in comparison to BON3 and BON3SQ equal to zero. The findings are virtually equivalent to the effect estimated by RAND for "Test Cell C" (4.8%), which offered bonuses for 3-year enlistments and even higher bonuses for those enlisting for 4-years (Dertouzos et al., 1989).

However, the *marginal* effects of increasing bonuses above the level reached in July 1984 are very small, negative, and not statistically significant. The estimate is derived by evaluating the first derivative of the model with respect to BON3 at the July 1984 value of the variable. The implication is that additional bonuses would not increase GSMA enlistments and cannot be justified if used only for that purpose. However, the primary objective of the bonus program has been to channel enlistees into hard-to-fill MOSs and to increase enlistment terms. These effects must be taken into account in setting the budget for enlistment bonuses.

An interesting finding is that the Bonus Buyup Program has a significant effect on GSMA supply (about 0.065). In 1987 the Army was dissatisfied with the term of enlistment decisions being made by enlistees and implemented the Bonus Buyup Program.[17] The program was widely available and in effect amounted to a pay raise for GSMAs — as long as they signed up for 5 or 6 years. We believe that the wide availability of the Buyup Program explains why it had a positive effect on GSMA supply, while the basic bonus program had no marginal effect after July 1984.

Finally, the policy changes implemented in FY86 (POL86) had a strong effect on GSMA enlistments (0.21).

A.4.2 Summary Statistics

The summary statistics are the same for the two models (at the level of accuracy reported). The R BAR SQ of 0.717 indicates that the models explain most of the variation in GSMA

17. The dissatisfaction was a result of the "DLINK" policy change, implemented in January 1986, which forced enlistees to choose either ACF benefits or bonuses. They generally chose ACF benefits and shorter enlistment terms.

enlistments. As mentioned earlier, the DW statistic indicates that the residuals are autocorrelated, but this does not affect the coefficient estimates.

The within-sample prediction errors are similar and relatively small. "Spikes" would indicate evidence of an omitted variable, e.g., a policy change affecting all battalions in a given year. No spikes are observed.

A.4.3 Out-of-Sample Forecasting Tests for FY89

Forecasting tests are undertaken using actual values of the variables, and elasticities from Models 1 and 2 estimated with data through FY88. Model 1 does much better in the forecasting test: both the root mean square error and the total error for FY89 are substantially lower for Model 1. The error composition analysis indicates the SEE for Model 2 is slightly lower, but a greater percentage of its forecasting error is systematic.

A.5 SUMMARY AND CONCLUSIONS

The study estimates the effects of the Army's education benefits program on the supply of Army GSMA enlistments. Estimates are obtained using regression analysis with monthly battalion-level data for the period FY1981-89. The estimates are based on a large sample of 5,184 observations, with new and improved measures for key factors. In particular, education benefits variables take into account both the level of benefits and the coverage of the program.

Estimates are obtained using the fixed effects technique. The coefficients have the expected signs and the magnitudes are generally plausible. Because of the large sample and improved measures of variables, the standard errors are relatively small. The results are consistent with the findings of previous studies.

The study estimates an ACF elasticity of 0.14, when the level of benefits and MOS program coverage are combined into a single variable (Model 1). If two variables are used, the benefits elasticity falls to 0.11; the elasticity of coverage is 0.23.

The *total* effect of changes in the ACF program consist of the marginal effects of changes in benefits and coverage. Historically, as the ACF program expanded, both benefits and coverage tended to increase. If this continues, the two models are likely to yield similar forecasts of the total effects of program changes.

Model 1 is simpler and it forecasted more accurately in the test period of FY89. Barring great changes in the relationship between benefits and coverage, we would use Model 1 for policy analysis purposes.

A.6. TRENDS IN THE VARIABLES USED TO ESTIMATE GSMA MODELS

This section provides trends by fiscal year in variables used to estimate the enlistment models (table A.4). Totals are reported for the variables GSMA, GOALA, GOALNOTA, and ADV. Annual averages are given for all the other variables.

A.7. ESTIMATES OF GSMA MODEL 1 USING ALTERNATIVE MEASURES OF CIVILIAN EARNINGS

This section reports estimates of Model 1 obtained using alternative measures of relative military pay (table A.5). In the main text, relative military pay was constructed using a measure of youth earnings. To construct a monthly battalion-level series on youth earnings, it was necessary to estimate a youth earnings forecasting model, and to construct a monthly battalion-level database containing the explanatory variables in the model (see Section A.8). Because of the difficulty of obtaining data on youth earnings, previous researchers have often used wages of all workers in manufacturing to construct a relative military pay variable.

If one uses manufacturing wages instead of the youth earnings, the estimate of the pay elasticity declines by more than half, from 1.20 to 0.53; the t-value declines sharply, from 11.26 to 6.08. The estimate of the ACF variable increases from 0.14 to 0.17. The SEE of the model also increases slightly. Therefore, by using the overall wage series, one obtains biased estimates for the ACF and pay elasticities and a poorer fitting model.

Table A.4. Trends in variables included in the GSMA models

Variable	1981	1982	1983	1984	1985	1986	1987	1988	1989
GSMA	31,650	51,251	63,510	50,230	54,879	64,460	57,949	54,189	50,437
MILPAY	0.968	1.058	1.071	1.048	1.069	1.076	1.075	1.071	1.092
UNEMP	7.346	9.095	10.125	7.913	7.344	7.192	6.626	5.746	5.303
ACF	0.409	0.588	0.575	0.618	0.704	0.756	0.523	0.476	0.554
ACFPV[a]	0.690	0.914	0.830	0.774	0.906	1.009	0.941	0.892	0.853
ACFCOV	0.590	0.644	0.694	0.799	0.777	0.750	0.555	0.534	0.650
BONUS[b]	0.012	0.023	0.027	0.034	0.046	0.460	0.023	0.023	0.032
BON3	0.000	0.001	0.004	0.010	0.026	0.027	0.020	0.017	0.019
BUYUP	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	1.0
RECR	4,715	4,826	4,915	4,917	4,965	5,158	5,269	5,447	5,760
GOALA	26,944	45,119	56,825	61,467	61,675	60,794	60,561	55,079	51,315
GOALNOTA	117,418	72,243	81,090	82,388	70,603	66,754	67,080	59,269	64,040
POL86	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0
ADV[c]	26,408	23,648	26,622	20,354	29,860	26,489	28,546	24,691	21,089
QMA[d]	2.517	2.486	2.480	2.441	2.339	2.261	2.182	2.158	2.141
MA	5.247	5.199	5.193	5.138	4.944	4.813	4.639	4.580	4.549

a. Divided by cost-of-college price index.
b. Divided by present value of civilian earnings of youth.
c. In thousands of dollars.
d. In millions.

A.8. ESTIMATION OF A YOUTH EARNINGS FORECASTING MODEL

Civilian pay is an important explanatory variable in the regression model. Previous studies indicate that the variable should be constructed with data on youth earnings, but monthly battalion-level data are not available. We address the data problem by estimating a youth earnings forecasting model with annual state-level data for the period 1977-87.

Table A.5. Estimates of Model 1 using alternative civilian earnings series

Variable	Earnings of Youth Coeff.	Earnings of Youth t-Stat.	Wages for all Workers Coeff.	Wages for all Workers t-Stat.
MILPAY	1.20	11.2	0.53	6.08
UNEMP	0.59	32.33	0.68	41.89
GOALA	0.28	28.26	0.31	32.08
GOALNOTA	-0.09	8.37	-0.11	10.21
RECR	0.15	4.76	0.20	6.39
ADV	0.05	8.55	0.04	7.70
ACF	0.14	10.51	0.18	13.73
BON3	4.3	23.10	1.31	4.29
BON3SQ	-84.22	1.87	-5.53	2.34
BUYUP	0.06	5.73	0.09	9.07
POL86	0.20	21.33	0.21	22.36

Within-Sample Summary Statistics	Earnings of Youth	Wages for all Workers
OBS	5,184	5,184
DF	5,120	5,120
R BAR SQ	0.717	0.712
SEE	0.178	0.179
RHO	0.34	0.345
DW	1.32	1.31

Within-Sample Prediction Errors (%)*	Earnings of Youth	Wages for all Workers
FY82	3.84	3.67
FY83	-4.82	-5.34
FY84	3.19	3.27
FY85	-1.82	-2.03
FY86	-0.26	0.50
FY87	-0.14	-0.64
FY88	-1.68	-1.23
FY89	3.31	2.49

Out-of-Sample Forecasting Tests for FY87	Earnings of Youth	Wages for all Workers
FORECAST	53,912	52,756
ACTUAL	50,437	50,437
ERROR	3,475	2,319
% ERROR	6.89	4.60
RMSE (%)	0.245	0.230

Error Composition Analysis: Actual = A_0 + A_1Prediction + Error	Earnings of Youth	Wages for all Workers
MEAN BIAS	0.103	0.045
REGRESSION	0.112	0.099
RANDOM	0.785	0.856
A_0 6.12	6.28	
STD ER A_0	1.29	1.29
A_1 0.87	0.89	
STD ER A_1	0.012	0.012
R BAR SQ	0.903	0.903
SEE	15.72	15.69

* Error = (Actual - Predicted)/Actualx100

We assume that youth earnings is a positive function of wages of all workers and a negative function of unemployment. Annual state-level data on earnings of 18- to 24-year-old males were obtained from the March *Current Population Surveys (CPS)* for 1978-88, so our sample consists of data for 1977-87. The *CPS* collects data on annual earnings in the previous year. The data were processed by Dr. Peter Kostiuk of the Center for Naval Analyses. Data on wages and unemployment were obtained from the BLS, *Employment and Earnings*.

We assume a loglinear model and estimate it using the fixed effects technique. The results are given in table A.6. The model fits the data reasonably well, and there is little evidence of one-period autocorrelation. The estimates of elasticities are 0.70 for wages and -0.062 for unemployment.

In a previous study we collected data on youth earnings from the 1980 Census at the county level and aggregated these to obtain observations for battalions. The 1979 observations were aged using the forecasting model. A monthly battalion-level database on wages and unemployment was constructed using monthly observations for these series at the state and MSA-level. These data were obtained from the BLS, *Employment and Earnings* reports for FY1980-89.

A.9 ANALYSIS OF THE EFFECTS OF ACF BENEFITS AND BONUSES ON THE TOE DISTRIBUTION OF GSMA ENLISTMENTS

Loglinear transfer function models are estimated relating ACF benefits and bonuses to the distribution of GSMA enlistments by term of enlistment.[18] The dependent variable is the logarithm of the percentage of GSMAs enlisting for 2, 3, 4, 5, or 6 years of service. The model for each TOE is a function of ACF benefits, bonuses, and other factors affecting the term of enlistment choice. Estimates are obtained with national monthly-level data for the period FY1981-89.

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18. For discussion of transfer function models and procedures for estimating time-series models see Pindyck and Rubinfeld (1981).

Table A.6. Estimates of youth earnings forecasting model

Variables	Coefficient	t-Statistic
WAGES	0.70	34.48
UNEMP	-0.062	3.73

SEE = 0.088 R BAR SQ = 0.705 DW = 1.70

Estimated with annual state-level data, 1977-87, using the fixed effects technique.

EARNINGS = (logarithm of) annual earnings of 18- to 24-year old male, full-time, year-round workers. (Sources: Current Population Surveys, 1978-1988; data provided by Dr. Peter Kostiuk of the Center for Naval Analyses.)

UNEMP = (logarithm of) overall civilian unemployment rate. (Source: Bureau of Labor Statistics, *Employment and Earnings*.)

WAGES = (logarithm of) average hourly earnings of production workers in manufacturing. (Source: Bureau of Labor Statistics, *Employment and Earnings*.)

Two factors besides ACF benefits and bonuses are included: the Buyup Program and a policy change (DLINK) that eliminated the possibility of an enlistee obtaining both a bonus and the ACF benefits. To measure its effects, we use a dummy variable equal to 1.0 starting in January 1986 and zero otherwise.

The models include moving average terms selected after preliminary estimations were made using ordinary least squares. We also include monthly seasonals for the TOE 4 model; these were not significant in the other models. To simplify the tables, we omit the MA terms and the seasonals.

The results indicate that ACF benefits reduce the term of enlistment (see table A.7). The ACF variable has a positive effect in the TOE 2 model and a negative effect in the TOE 3 and 4 models. The reverse is true for bonuses: BON3 has a small positive effect on TOE 4 and a negative effect on TOE 2 and 3. Since the BON3 variable is in levels, the estimates are not elasticities. To derive elasticities, we multiply the coefficients by the mean value of BON3 (0.0277) over the period that three-year bonuses were offered, i.e., July 1984 - September 1989. The multiplication yields elasticities of -0.09, -0.051, and 0.057 for TOE 2, TOE 3, and TOE 4, respectively.

Table A.7. Estimate of loglinear TOE distribution models for GSMA enlistments

	DEP VAR = Logarithm of pct. GSMA in TOE				
Variables	TOE 2	TOE 3	TOE 4	TOE 5	TOE 6
CONSTANT	-1.49	-1.10	-0.78	0.0036	0.0058
(17.09)[b]	(15.60)	(18.51)	(1.18)	(1.67)	
ACF	0.65	-0.056	-0.10	--	--
(6.26)	(0.70)	(2.09)			
BON3[a]	-3.44	1.87	2.12	--	--
(1.28)	(0.84)	(1.61)			
DLINK	0.25	0.077	-0.20	--	--
(3.30)	(1.21)	(5.21)			
BUYUP	-0.19	-0.72	0.24	0.060	0.034
(2.22)	(9.70)	(5.43)	(10.36)	(5.87)	
R BAR SQ	0.62	0.89	0.73	0.93	0.92
DW	1.89	1.93	1.91	1.94	1.90
SEE	0.16	0.12	0.068	0.0090	0.0084
Q-SIGNIF	0.91	0.32	0.77	0.65	0.0016

a. Variables are in levels rather than logarithms. Multiply by mean value of 0.0271 (07/84-09/89) to estimate elasticity.
b. The t-statistic is given in parentheses.

The DELINK program increased the probability that an applicant would enlist for 2 or 3 years. Given a choice between ACF benefits and bonuses, enlistees chose the ACF benefits and shorter enlistment terms.

The Buyup Program led a concerted effort by the Army to increase enlistment terms: 2- and 3-year enlistments were reduced; 4-, 5-, and 6-year contracts were increased. Indeed "Buyup alone" explains the increase in 5- and 6-year enlistments observed in FY1987-89.

The results indicate, as expected, that ACF benefits and bonuses affect the TOE choice made by enlistees. These effects should be taken into account by policy makers when they assess the costs and benefits of the programs.

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APPENDIX B

ARMY COLLEGE FUND USAGE AND COST

Solid estimates of the cost of the ACF are an important prerequisite for a cost-effectiveness analysis of the program. However, because the bulk of military education benefits are not used until a soldier leaves the Army and because the ACF was not fully implemented until FY82, data on actual ACF usage has only recently become available. To date, cost-effectiveness analyses of the ACF have had to rely on usage estimates from the Vietnam-era G.I. Bill. But, because of the substantial differences in the programs, these derived cost estimates have always been of suspect quality.

In this Appendix, we review the existing estimates of ACF costs that use actual program experience and develop new estimates based on education benefits usage captured in the FY82 Education Benefits Cohort File (EBCF). Before examining the existing research, we describe the cohort file, as it is central to much of the recent analysis on ACF costs.

B.1 FY82 EDUCATION BENEFITS COHORT FILE

The cohort file includes records on a 10% random sample of nonprior service accessions into the enlisted ranks of the Army during FY82. It includes individuals from all quality categories enlisting in all Military Occupational Specialties (MOSs). Data which are merged from three sources:

- Defense Manpower Data Center cohort records, include basic demographic information, such as race and gender; accession variables, such as education at entry and AFQT score; and separation information.
- U.S. Army Finance and Accounting Center files report contributions made to the education benefits program.
- Veterans' Administration records provide data on education benefits paid to the soldiers in the file.

The cohort file has been updated at least once. The original version of the file tracked benefits payments and separation information through September 1987. The update extends the observation period through July 1989. There are approximately 8,100 usable observations in the file.

B.2 PREVIOUS RESEARCH ON ACF COSTS

Two published studies have estimated ACF costs using the experience of soldiers actually eligible for the program.[1] Schmitz et al. (1987) estimate the per accession cost of the ACF using a data set similar to the FY82 EBCF. It contains a random sample of soldiers who accessed in both FY81 and FY82, and tracks the use of education benefits through FY86. Schmitz et al. calculate the discounted present value of the average benefits used per ACF-eligible accession, which is the actuarial cost of the benefit, as

(1) Cost per accession = Maximum ACF benefit x Discount factor
x Proportion of accessions using any benefits
x Proportion of benefit used (by users)

To provide current cost estimates, they use the maximum benefit amounts in the current ACF program: $8,000 for 2-year enlistments, $12,000 for 3-year terms, and $14,400 for 4-year enlistments. The discount factor is a function of the time from accession to the midpoint of the period over which benefits are typically used.

They estimate the proportion of accessions using any benefits by multiplying (1) the proportion of accessions making the contributions required to receive ACF benefits, (2) the proportion of contributors serving the minimum time necessary to qualify for benefits, (3) the proportion of soldiers with minimum service requirements separating at the end of the first term, and (4) the proportion of separatees using any benefits.[2]

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1. In addition, cost estimates using ACF benefit payment histories are prepared by the DOD actuary as a basis for determining the budget cost of the program.

2. Schmitz et al. estimate costs for soldiers leaving at the end of their first term and for those who reenlist. They do not consider the costs incurred by those who leave before ETS but can still claim benefits.

All of the above factors can be directly measured using their data set except for the average benefit used, which must be predicted because the complete period over which benefits can be used is not observed. In the file, only one to three years of postservice benefits use are recorded for FY81 accessions, depending on the length of the soldier's initial term, but benefits may be used for up to 10 years after separation. Schmitz et al. use an exponential smoothing technique to extend the pattern of benefits use by time since separation beyond the observation period. The cost estimates by initial term of service from their paper are shown in table B.1.

In Hogan et al. (forthcoming), ACF costs are estimated using a multivariate model that links the use of education benefits to soldier characteristics and the level of benefits offered. The advantage of this approach over a simple cost accounting is that costs can be predicted for accession cohorts and benefit levels different from those observed in the estimation data. This has direct application to a cost-effectiveness analysis where the expected costs for alternative ACF programs with varying benefit levels must be estimated. The model in Hogan et al. is estimated with the original version of the EBCF (observation period through FY87), using only those soldiers who separated at the end of their first term of service.[3]

Table B.1. Previous ACF cost estimates*

	Enlistment Term		
Study	2 Years	3 Years	4 Years
Schmitz et al. (1987)	$2,652	$1,618	$1,152
Hogan et al.	---	1,300	---
DOD actuary (FY90)	1,561	1,342	1,153

*Discounted present value of cost per ACF accession in the current program.

3. Ignoring separations before and after the first term, ETS will understate ACF costs, but not significantly. Soldiers leaving at the end of the first term have far higher average benefits usage than the rest of an accession cohort.

The specification of the usage model is derived primarily from a theoretical model of the demand for education (see below). In addition, Hogan et al. face the same problem of estimating total usage with an observation period that does not encompass the statutory period allowed. Their approach is to measure the relationship between total benefits used and the length of the observation period (which varies in the data because of different separation dates), and use that information to estimate how many months after separation benefit usage typically stops. Benefit usage is predicted from their model at the point of maximum usage.

Even though Hogan et al. use essentially the same data set as Schmitz et al., the former obtain different estimates of the per accession cost of the ACF (see table B.1). The different results can be traced to the different methodologies used to predict average benefits used by separatees (see Smith and Hogan, 1989). The update of the EBCF used here adds to our ability to predict total benefits used. Usage patterns for 2-year enlistees -- the group with the longest postseparation observation period -- show a steep increase in the original data set during the first and second years after separation, followed by slower growth at the third year. With data through July of 1989, that three-year observation period is extended to 3- and 4-year enlistments.

B.3 METHODOLOGICAL APPROACH

Our approach in estimating ACF costs is similar to that used by Hogan et al. First, we estimate a multivariate model of the discounted present value of total (VEAP plus ACF) education benefits usage. With this model we can predict total education benefit costs for high-quality soldiers who enlist with different benefit offers. The share of total education benefit costs borne by the ACF is determined by the fraction of total education benefit package provided by the ACF. Therefore, ACF costs per accession, C_{ACF}, can be calculated as

$$(2) \qquad C_{ACF} = U(B_{ACF}+B_{GI}) \times [B_{ACF}/(B_{ACF}+B_{GI})]$$

where U is the discounted present value of education benefits used, given the total benefits offered under the ACF and New GI Bill, and the Bs are the benefit levels for those programs. The remainder of this section outlines the benefits usage model.

The specification of the benefits usage model is derived from two considerations: an economic model of demand for education and the peculiarities of the EBCF. The economic model tells us that the demand for education and, therefore, benefits use will increase with the net financial returns to additional schooling. The net financial returns, in turn, are a function of (1) the increase in lifetime earnings resulting from more education and (2) the costs of that education, including both out-of-pocket costs and foregone earnings.[4] We include the following variables to measure differences in demand for education:

- **AFQT.** AFQT interacts with demand in two ways. As the returns to education are greater for those with more aptitude, benefits usage should be greater for those with higher AFQT scores. However, individuals with higher AFQT scores also earn more, increasing the opportunity cost of additional education. AFQT is included as the percentile score measured at entry.

- **Education.** The level of education will affect usage in three ways. First, more education increases an individual's civilian earnings, thereby increasing the cost of more schooling. Second, because of the "sheepskin effect," additional schooling to complete a degree will be particularly valuable, increasing the demand by soldiers with some college credits. Third, a high school diploma is often a prerequisite for college enrollment, reducing the demand among nongraduates for this form of postservice education. Because of the different effects expected by level of education, we include dichotomous variables for the following levels: less than high school, graduate equivalent degree (GED), high school diploma graduate, some college, and college diploma.

- **Demographic characteristics.** Race, gender, and marital status will capture factors affecting both the opportunity costs, such as foregone earnings, and the returns to additional education. Dichotomous variables are therefore included for race (white, black, and other), gender, and marital status at entry.

- **Military occupation.** The value of military training and experience in the civilian labor market will vary across occupations, affecting the opportunity cost of additional education. We include dichotomous variables for six occupational categories (defined by DOD occupational codes): combat (0), electronics and communications (1,2), medical and other technical (3,4), administrative and support (5), mechanics and craftsmen (6,7), and service and supply (8).[5]

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4. Hogan et al. has a more rigorous explication of the demand for schooling model.

5. Soldiers in the non-occupational category (code 9) and those with missing codes are excluded from the analysis.

The level of education benefits provided by the military also affects benefit use by reducing the opportunity costs of additional education. In the FY82 cohort file there are only three possible levels of benefits: ACF for 2-year enlistments, ACF for 3- and 4-year enlistments, and VEAP. Because of the special nature of the 2-year enlistment term, we will estimate separate models for 2- versus 3- and 4-year initial terms, leaving the only variation in benefits due to ACF eligibility. Therefore, we include a dichotomous variable for ACF to capture differences in education benefits levels.

The structure of the EBCF requires that we add some additional variables to the specification. As in the previous research, we are concerned about estimating the *maximum* benefits usage from a data set with a limited observation period. We follow Hogan et al. in using the months between separation and July 1989 (and its square) to estimate how education benefits usage increases after separation. Unlike that study, however, we want to measure all benefits usage by the accession cohort, not just the usage of those who separate at ETS. This requires controlling for date of separation because those who separate before ETS typically have lower potential education benefits due to the shorter period over which they make contributions. In a data set with an essentially fixed observation period for all soldiers, it is statistically impossible to include both date of separation and months since separation in the same model.

After some experimentation, we selected the following specification to capture both effects:

$$U_i = \sum \alpha_j X_{ij} + \beta_1 S_{<ETS} + \beta_2 S_{\geq ETS} + \beta_3(S_{\geq ETS}T) + \beta_4(S_{\geq ETS}T^2) \tag{3}$$

where U_i: Discounted present value of total education benefits used for the ith individual;

X_{ij}: Soldier characteristics listed above;

$S_{<ETS}$: Equals 1 if the soldier separates before ETS, and 0 otherwise;[6]

$S_{\geq ETS}$: Equals 1 if the soldier separates at or after ETS, and 0 otherwise; and

6. ETS information is not available in the EBCF. We define "before ETS" as three or more months before the estimated ETS, which equals the soldier's accession date plus the number of months in the initial term of service.

T: Months from date of separation to the end of the observation period (July 1989).

In this specification the reference group is those soldiers who remain in the Army throughout the observation period, roughly those serving at least two terms. The average difference in benefits usage between those separating before ETS and the stayers, controlling for the other variables, is measured by β_1. The average difference between those separating at or after ETS and the stayers is measured by β_2 through β_4, and it depends on time since separation, T. We expect that β_3 and β_4 will have positive and negative signs, respectively, indicating that cumulative benefits usage increases after separation, but at a decreasing rate. We also expect, at least in the 3- and 4-year results, that the month of maximum benefits accumulation implied by these coefficients probably exceeds the mean number of postseparation months observed in the data set.[7] It seems likely that some benefits would continue to be used beyond the 36-month observation period available in the EBCF.

B.4 ESTIMATION RESULTS

Table B.2 displays the mean characteristics for the usable observations in the Education Benefits File by initial term length and ACF eligibility.[8] Approximately 7% of the FY82 cohort enlisted for 2-year terms. Because of the quality restrictions on 2-year enlistments, these soldiers are significantly different from the remainder of the cohort. They are more likely to be eligible for the ACF: 85% versus 26% for 3- and 4-year enlistments. Two-year enlistees also have higher average AFQT scores and are more likely to be high school graduates, white males, and not married at accession. There is some difference in the occupational distribution as well, with proportionately more 2-year terms in the administration and service occupations in FY82. Finally, soldiers with an initial term of 2 years are less likely to leave before their ETS (13% versus 28%), but they are also

7. The month of maximum benefit accumulation, T^{MAX}, is calculated by setting the derivative of the benefit equation with respect to T equal to 0, or $T^{MAX} = \beta_3/(2\beta_4)$.

8. We consider a soldier to be "ACF-eligible" if he or she has an AFQT score greater than 50, is a high school diploma graduate, and enlists in an occupation that was included in the ACF program during FY82. There is an education benefits variable on the cohort file that records program eligibility, but ACF-eligibility rates calculated from this variable appeared to be too low.

Table B.2. Sample characteristics

Variable	2-Year Terms ACF[d]	2-Year Terms Others	3-, 4-Year Terms ACF	3-, 4-Year Terms Others
Mean AFQT[a]	73.7	54.5	72.4	41.8
Education (%)[a]				
<High school	.0	.0	.0	.10
GED	.0	.0	.0	.031
High school	.85	.92	.85	.080
Some college	.13	.072	.11	.048
College	.028	.012	.036	.015
Race (%)				
White	.89	.76	.84	.63
Black	.085	.20	.13	.31
Other	.035	.036	.033	.056
Female (%)	.039	.084	.18	.090
Married (%)[a]	.050	.048	.15	.13
Occupation categories (%)				
Combat	.29	.27	.36	.30
Electronics/Communication	.17	.072	.29	.17
Technical	.033	.012	.093	.063
Administrative	.20	.17	.11	.14
Mechanical/Craftsman	.083	.34	.022	.21
Service	.23	.14	.13	.11
Separated before ETS (%)	.12	.16	.26	.29
Separated at/or after ETS (%)	.77	.69	.45	.40
Mean months after separation[b]		57.3		42.3
Sample Size[c]	459	83	1,933	5,609

a. Measured at accession.
b. Calculated for soldiers who separated at or after ETS. Mean is for both ACF-eligible and other soldiers.
c. Observations with complete data from the FY82 EBCF.
d. Eligible for ACF at enlistment

more likely to leave at the end of their first term (76% versus 41%). All these differences lead us to separate analyses for 2-year enlistments.

Within term of service categories, comparisons of ACF-eligible and other soldiers mirror the term of service comparisons. Again, because of quality restrictions, soldiers who are eligible for the ACF have higher AFQT scores, are more likely to be high school diploma graduates, and are more frequently white males. In FY82 the data suggest that the ACF was used to direct soldiers into combat and electronics/communications occupations. Early separations occur less often in the ACF-eligible group, but they are also less likely to make the Army a career.[9]

Table B.3 displays education benefits usage statistics for the soldiers in the EBCF. Although all soldiers were eligible for at least VEAP at accession, only 15% of the FY82 cohort used some military education benefits. This usage rate is lower than the rate for soldiers enlisting during the Vietnam-era G.I. Bill, which reflects, at least in part, the contribution requirements for VEAP and the ACF. Usage rates, however, vary significantly across initial term of service and ACF eligibility. Soldiers with 2-year enlistments are more likely to use some benefits; and, within term of service categories, ACF-eligible soldiers have higher usage rates than those eligible for just VEAP.

The averages for total benefits used show similar patterns. An ACF-eligible soldier enlisting for a 2-year term in FY82 could receive $15,200 ($7,200 from VEAP and $8,000 from the ACF), but the typical soldier in this category used only 36 cents of each dollar of benefits. From the government's point of view, the cost per dollar of benefit offered is even lower because benefits are paid in the future. Discounting benefits from the time of receipt to accession, the cost is just 27 cents per dollar of benefit offered.[10] For ACF-eligible soldiers with 3- and 4-year initial terms, who have potential benefits of $20,100, the cost per dollar of benefit offered is only 9 cents, reflecting both lower usage rates and the longer period before most benefits are used.

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9. These separation rate differences are correlated with the quality differences between ACF-eligible and ineligible soldiers. To assess the man-year effects of using the ACF instead of other enlistment incentives, we need to know whether ACF affects separation rates, holding constant soldier quality. We examine this issue in Appendix C.

10. We use an 8.5% nominal discount rate, which is recommended by the DOD actuary.

Table B.3. Education benefits usage

	2-Year Terms		3-, 4-Year Terms	
	ACF	Other	ACF	Other
Percent receiving benefits	.53	.19	.28	.070
Mean benefits ($):				
Undiscounted[a]	5,547	1,490	2,863	290
Discounted[b]	4,080	1,066	1,873	193
Sample size	459	83	1,933	5,609

a. Total benefits paid during the observation period including returned VEAP contributions, VEAP matching funds, and ACF benefits.
b. Benefits discounted from receipt to accession at 8.5%.

Tables B.4 and B.5 display the estimated benefits usage models for 2-year and 3- and 4-year initial enlistments. The dependent variable in all models is the discounted present value of total benefits used for the period from a soldier's accession date through July 1989. The models are estimated with ordinary least squares (OLS), so the coefficients can be interpreted directly as the change in total benefits used with a unit change in the dependent variable.[11] We present the results of three specifications: without any separation variables ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$), without the time-after-separation variables ($\beta_3 = \beta_4 = 0$), and the complete model.

11. Given the significant fraction of soldiers using no benefits, OLS parameter estimates are potentially biased. We tried estimating the models as tobits, a statistical procedure often used when the dependent variable is censored in this fashion. However, the normality assumption underlying the tobit was inappropriate in this application, as evidenced by the fact that mean benefit predictions from the tobit model were not close to the sample means.

Table B.4. Education benefits usage models for 2-year terms

Variables[a]	Model 1		Model 2		Model 3	
Intercept	-1,773	(-1.8)[b]	-4,343	(-4.5)	-4,294	(-4.5)
AFQT	65	(4.7)	59	(4.7)	59	(4.7)
Education (High school)						
Some college	-481	(-.82)	-111	(-.21)	-45	(-.08)
College	-819	(-.69)	-440	(-.41)	-359	(-.33)
Race (White)						
Black	-1,338	(-2.1)	-868	(-1.5)	-939	(-1.6)
Other	-470	(-.47)	-331	(-.36)	-483	(-.53)
Female	-211	(-.24)	225	(.31)	283	(.35)
Married	-2,442	(-2.9)	-1,765	(-2.3)	-1,707	(-2.2)
Occupation (Combat)						
Electronics/Communication	-22	(-.04)	287	(.53)	270	(.50)
Technical	-402	(-.35)	39	(.04)	32	(.03)
Administration	-297	(-.54)	-352	(-.70)	-385	(-.77)
Mechanical/Craftsmen	-126	(-.19)	-410	(-.69)	-412	(-.69)
Service	-1,208	(-2.3)	-759	(-1.6)	-763	(-1.6)
Army College Fund	1,727	(2.9)	1,387	(2.6)	1,364	(2.5)
Separated before ETS			-275	(-.40)	-286	(-.41)
Separated at/after ETS			4,035	(7.4)	-17,350	(-1.9)
x Time					846	(2.4)
x Time^2					-8	(-2.5)

a. Sample size is 542.
b. The t-statistics are in parentheses.

Table B.5. Education benefits usage models for 3- and 4-year terms

Variables[a]	Model 1		Model 2		Model 3	
Intercept	-443	(-4.9)[b]	-868	(-9.3)	-929	(-9.9)
AFQT	16	(10.4)	16	(10.5)	15	(10.3)
Education (High school)						
<High school	-576	(5.9)	-410	(-4.3)	399	(-4.2)
GED	-595	(-3.6)	-448	(-2.8)	-445	(-2.8)
Some college	550	(5.5)	533	(5.5)	533	(5.5)
College	-584	(-3.4)	-521	(-3.2)	-513	(-3.1)
Race (White)						
Black	-153	(-2.6)	-62	(-1.1)	-67	(-1.2)
Other	187	(1.7)	226	(2.1)	212	(2.0)
Female	-352	(-4.4)	-237	(-3.0)	-233	(-3.0)
Married	-486	(-6.9)	-351	(-5.1)	-337	(-4.9)
Occupation (Combat)						
Electronics/Communication	128	(1.8)	115	(1.7)	123	(1.8)
Technical	-408	(-4.0)	-364	(-3.6)	-359	(-3.6)
Administration	27	(.32)	49	(.60)	53	(.64)
Mechanical/Craftsmen	-128	(-1.7)	-154	(-2.1)	-149	(-2.1)
Service	-248	(-2.9)	-197	(-2.4)	-200	(-2.4)
Army College Fund	1,140	(15.4)	1,096	(15.3)	1,092	(15.3)
TOE 3	295	(5.4)	150	(2.8)	275	(4.6)
Separated before ETS			119	(1.9)	116	(1.9)
Separated at/after ETS			1,094	(19.5)	-1,979	(-1.3)
x Time					186	(2.6)
x Time^2					-3	(-3.0)

a. Sample size equals 7542.
b. The t-statistics are in parentheses.

Many of the results are similar across the term of service categories; and, therefore, we focus on the 3- and 4-year findings because the larger sample size allows more definitive conclusions. Most of the implications of the demand for education model are borne out in these results, including:

- AFQT is positively related to benefits usage, indicating that the increased returns to education for high-AFQT individuals outweigh the higher opportunity costs.

- Both individuals without a high school diploma, who do not have the normal prerequisite for a college education, and those who already have a college diploma use fewer benefits than those with a high school diploma only. However, individuals with some college use more benefits than high school graduates, which is consistent with the sheepskin effect.

- Holding other factors constant, differences in education benefits usage by race are small. However, we find that males and unmarried individuals use more benefits, on average.

- There are statistically significant differences in benefits usage by military occupation, but the magnitude of the differences is generally small.

Individuals who do not separate during the period covered by the cohort file and those who separate from the Army before ETS use fewer education benefits -- approximately $1,100 less (Model 2). Stayers use fewer benefits because full-time schooling, which is the fastest way to utilize benefits, is not available. Those who separate early probably have contributed less to VEAP on average, and therefore are entitled to a smaller benefit payout.

The results on benefits accumulation by time since separation are mixed. As expected, the benefits usage for those who separate at or after ETS increases with the time since separation, but at a decreasing rate. However, the estimated month of maximum benefits accumulation is slightly *less* than the mean number of postseparation months observed: 52 months for 2-year enlistments and 35 months for 3- and 4-year terms. There are two possible explanations for this somewhat unexpected result. The first is that, on average, all benefits accumulation is observed in the EBCF, but this seems unlikely given the differences between the points of maximum use across the term of service categories. The second possibility is that separating time in service effects from time since separation effects is simply too difficult using a data set where time in service and time since

separation essentially equal a constant.[12] To the extent that we underestimate total benefits usage, of course, we will also understate the costs of the ACF. For this reason, we consider a range of cost estimates in the cost-effectiveness analysis.

One of the advantages in using a multivariate model is that differences in benefits usage between ACF-eligible and VEAP-only soldiers can be isolated from differences in the average characteristics of these two groups. This is essential in correctly estimating how the average cost of education benefits for ACF-eligibles will respond to different levels of benefits. In table B.3, the difference in the discounted present value of benefits used by ACF-eligible and ineligible soldiers was approximately $3,000 for 2-year enlistments and $1,700 for 3- and 4-year enlistments. After adjusting for differences in the characteristics of the eligible and ineligible groups, the benefits usage differences drop to $1,400 and $1,100, respectively (Model 3).

Table B.6 displays our estimates of the per accession cost of both the FY89 ACF program and the reduced-benefits alternative used in the cost-effectiveness analysis. The discounted present value of total education benefits usage is predicted using Model 3 and the mean characteristics of high-quality accessions in the FY82 EBCF.[13] The following assumptions were applied:

- The separate models by term of service are used, as well as means by term of service.

- The separation variables in the usage model are predicted from the first-term attrition and reenlistment models described in Appendix C. A change in the level of benefits offered, therefore, has both direct effects on usage through the usage equation and indirect effects through changes in retention patterns.

- Benefits for soldiers separating at or after ETS were predicted using the value for months after separation which maximized usage.

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12. As an alternative approach, we also estimated models in which the dependent variable was total benefits used by month since separation, so that there were multiple observations on each individual in the sample. This model uses the monthly pattern of benefits accumulation *for each individual* in predicting where the maximum occurs, rather than variation in the postseparation observation period. Unfortunately, this approach did not yield better estimates than the model reported in the text.

13. Data availability problems prevented us from predicting usage using the characteristics of the high-quality members of the FY89 accession cohort, upon which the rest of the cost-effectiveness analysis is based. Comparing selected characteristics, however, suggested the differences were too small to have a significant impact on the cost estimates.

- For 4-year enlistments the current ACF offers higher benefits than were available in FY82. To predict usage for these soldiers, we increase the ACF coefficient in table B.5 in the same proportion as benefits increased (i.e., 14,400/12,000). We use the same approach in predicting usage for the reduced benefits program.

Table B.6. ACF cost estimates

	Enlistment Term		
	2 Years	3 Years	4 Years
Discounted present value of total benefits used ($):			
FY89 ACF	3,580	1,983	1,976
Reduced ACF	2,898	1,448	1,308
ACF proportion of total benefits:			
FY89 ACF	.526	.597	.640
Reduced ACF	.357	.426	.471
ACF costs per accession ($):			
FY89 ACF	2,122	1,184	1,265
Reduced ACF	1,035	616	615

The proportion of the benefits provided by the ACF is calculated using the maximum benefits offered under the current ACF and VEAP. VEAP is used instead of the New GI Bill because the predictions of total usage are based on the ACF-VEAP program.

For both 3- and 4-year enlistments, our estimated ACF costs for the FY89 program are relatively close to the DOD actuary's most recent estimates, as shown in table B.1. Although the parameter estimates are not completely satisfactory, the usage model for 3- and 4-year terms does produce ACF cost estimates for the current program that are close to the "official" estimates used for budgeting purposes. For 2-year enlistments, however, we find a per accession cost that is significantly higher than the actuary's estimate. At least part of the discrepancy results from an adjustment made in the actuary's calculations, but not ours, for the longer benefits payout period under the New GI Bill as compared with VEAP.[14] Holding constant the benefits available, a longer payout period reduces the average benefits actually used because a smaller proportion of individuals stay enrolled in college for the longer period.

As the usage model shows how education benefits use changes as a function of the level of benefits offered, we can also use it to predict the expected costs of a hypothetical ACF program, one with 50% lower benefits. The results in table B.6 show that the per accession cost falls by approximately the same proportionate amount as the benefit level.

For the baseline case of the cost-effectiveness analysis, we use a combination of the DOD actuary's estimates and results from our usage model. In particular, the actuary's estimates are taken as the costs of the current program. We adjust these amounts using the ACF parameters in tables B.4 and B.5 to estimate costs for the reduced-benefits program. To test the sensitivity of the cost-effectiveness results to different ACF cost estimates, we also evaluate cost-effectiveness using our estimates both for the FY89 and reduced-benefits programs, as displayed in table B.6.

B.5 SUMMARY

In this Appendix we used the updated version of the FY82 Education Benefits Cohort File to estimate the per accession cost of the Army College Fund. Our approach was to estimate a multivariate model of education benefit usage as a function of soldier characteristics, including the benefit level for which an individual was eligible; project the discounted present value of usage for

14. New GI Bill benefits are paid out over 36 months; VEAP benefits for 2-year enlistments, over 27 months.

the FY89 and reduced-benefits programs; and determine the Army College Fund's share of those costs. Except for 2-year enlistments, the cost estimates derived from this methodology are similar to the estimates of the DOD actuary. We use a combination of actuary estimates and results derived from the usage model in assessing ACF cost-effectiveness.

B.6 REFERENCES

Hogan, Paul F., Smith, D. A. and Stephen Sylwester. "The Army College Fund: Effects on Attrition, Reenlistment and Cost," in Curtis Gilroy, David Horne, and D. Alton Smith, eds, *Military Compensation and Soldier Retention.* U.S. Army Research Institute, forthcoming.

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APPENDIX C

THE ARMY COLLEGE FUND AND SOLDIER RETENTION

One of the factors complicating the debate about the cost-effectiveness of the ACF is that, unlike other enlistment incentives, the ACF may affect soldier retention as well as enlistment behavior. Because most of the use of military education benefits occurs after a soldier leaves the Army, education benefits may increase the incentive to leave at the first-term reenlistment point. On the other hand, receipt of education benefits is conditional on a minimum period of service, which means that eligibility for benefits may reduce first-term attrition. From theoretical arguments alone it is impossible to determine whether the average man-years generated by an ACF enlistment will be more or less than the average man-years obtained with other enlistment incentives.

Because of these possible retention effects, we use total man-years, rather than enlistments, as the measure of "effectiveness" in the cost-effectiveness analysis. This requires that, in addition to knowing the enlistment effects of the ACF, we must also estimate expected man-years per enlistment for different levels of ACF benefits. We do this using multivariate models of first-term attrition and reenlistment, both of which include education benefits as an explanatory variable. In contrast to estimating the retention implications of ACF benefit changes from simple means for ACF-eligible and ineligible soldiers, this approach allows us to predict man-year effects while holding constant other retention-related characteristics of the enlisted force.

This Appendix is organized as follows: Section C.1 reviews the existing research on the attrition and reenlistment effects of the ACF; Section C.2 discusses our approach to measuring both retention effects, which uses the FY82 Education Benefits Cohort File (EBCF) described in Appendix B; and Section C.3 presents our findings.

C.1 PREVIOUS RESEARCH ON ACF RETENTION EFFECTS

First-Term Attrition. Three recent studies have examined the relationship between first-term attrition and the level of education benefits for which a soldier is eligible. Using the original version of the EBCF, Hogan et al. (forthcoming) estimate multivariate models of the probability of

staying 13 months, 21 months, and to the expiration of the soldier's term of service (ETS). Holding constant such service characteristics as occupation and term length and such demographic characteristics as education at entry and race, Hogan et al. find that soldiers eligible for the ACF have lower attrition than those eligible for VEAP only.[1] The differences, however, are relatively small (e.g., 3 percentage points on an average stay-to-ETS rate of 73%) and not statistically different from zero.

Using data on soldiers who entered the Army during the Educational Assistance Test Program (EATP) in FY81, Schmitz (1988) compares the probability of completing the first term for soldiers eligible for UltraVEAP (which became the ACF) and SuperVEAP, a program with lower benefit levels. Holding constant a variety of job and personal characteristics, he finds that term completion rates for UltraVEAP-eligible soldiers are 3 percentage points higher when the enlistment term is 3 years and 5.8 percentage points *lower* when the initial term is 4 years. Both effects are significantly different from zero in a statistical sense.

Warner and Solon (forthcoming) estimate first-term completion models for soldiers in the infantry who accessed from FY74 through FY84. In addition to demographic characteristics, the models include the discounted present value of the education benefits for which a soldier was eligible. They find that higher education benefits are associated with lower term completion rates for soldiers enlisting for initial terms of 3 or 4 years, although the effects are very small.

In summary, the existing research shows only small effects of different levels of education benefits on first-term attrition rates. Some of the results support the hypothesis that eligibility for higher education benefits reduces first-term attrition, but the magnitude of the estimated effects are too small to have any practical importance.

First-Term Reenlistment. Several recent studies have examined the relationship between reenlistment rates and the level of education benefits for which a soldier is eligible. Table C.1 summarizes the findings.

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1. In our terminology a soldier is "eligible" for the ACF if he meets the education, AFQT, and military occupation criteria at enlistment. Of course, he can only receive benefits if he satisfies other requirements, such as contributing a minimum amount to the program.

Table C.1. Education benefits and reenlistment rates

Study	Difference in Reenlistment Rates (percentage points) 2 Year	3 Year	4 Year	All
Schmitz (Ultra v. SuperVEAP)				
Selected MOSs	-0.2	-1.2	0.1	
Hogan et al. (ACF v. VEAP)				
All MOSs		-5.9*	-4.8	
Smith et al. (ACF v. VEAP)				
Infantry				-5.6*
Mechanical Maintenance				-2.4*
Administration				-3.2*

* Statistically different from zero at 5% level.

Again comparing soldiers who enlisted under different education benefits programs during the EATP, Schmitz finds no difference in first-term reenlistment rates between those eligible for UltraVEAP and SuperVEAP, controlling for soldier characteristics and other factors.

The difference between the benefits paid under UltraVEAP and SuperVEAP was relatively small. Two other studies, which incorporate a wider range of education benefits programs, do find a benefits-reenlistment link. Hogan et al. estimate a reenlistment model using the original version FY82 EBCF and find that, other factors held constant, soldiers with 3- and 4-year initial contracts who were offered the ACF at enlistment have reenlistment rates that are 5 to 6 percentage points lower than soldiers eligible only for VEAP.

A drawback to using a single cohort to estimate ACF retention effects is that, for high-quality enlistments, ACF eligibility is perfectly correlated with the occupation chosen by the individual at enlistment. Because the ACF is used to attract individuals into what are commonly viewed as less attractive occupations, such as the Combat Arms, comparing the reenlistment rates of

high-quality soldiers who are and are not eligible for the ACF will overstate any negative reenlistment effects of the ACF. The analysis in Hogan et al. implicitly uses non-high-quality enlistments in ACF-eligible occupations to separate ACF and occupation effects on reenlistment rates, but the success of this approach depends heavily on functional form assumptions in the statistical model.

Smith et al. (forthcoming) estimate first- and second-term reenlistment models using data on soldiers who enlisted from FY74 through FY84 in the Infantry, Mechanical Maintenance, and Administration Career Management Fields (CMFs) and include the discounted present value of education benefits offered at enlistment as an explanatory variable. Because the value of benefits varied for high-quality enlistments in the same occupation as education benefits programs changed over the analysis period, the ability to disentangle the effects of education benefits and occupations on reenlistment rates is stronger than with a single cohort. For the Infantry, Smith et al. find that first-term reenlistment rates are 5.6 percentage points lower if the soldier is eligible for the ACF compared to VEAP. The differences are smaller for the Mechanical Maintenance and Administration CMFs, 2.4 percentage points and 3.2 percentage points, respectively. These findings suggest an all-Army result that lies somewhere between the estimates of Schmitz and Hogan.

In summary, there is empirical evidence that education benefits do have a negative effect on reenlistment rates. Moreover, the magnitude of the effects is not small. A 3 percentage point difference in reenlistment rates represents a 6% to 10% reduction, depending on the occupation. Combining the first-term attrition and reenlistment effects, existing studies support the hypothesis that the average man-years generated by enlistments under the ACF will be less than the average man-years from soldiers enlisting under other incentives. In the next two sections, we revisit the question of retention effects using the extended version of the FY82 EBCF described in Appendix B.

C.2 ATTRITION ANALYSIS

Approach. To predict expected man-years during the first term of service, we estimate a multivariate model which includes both characteristics of the soldier and the conditions of his or her enlistment. The specification of that model, which is drawn primarily from selected empirical studies

of first-term attrition, includes the following variables:[2]

- **Education and AFQT.** The attrition studies of Army enlisted personnel by Baldwin and Daula (1985) and Warner and Solon, among many others, find that soldiers with more education and a higher AFQT score at entry have a lower probability of leaving before their first-term ETS. We include the AFQT percentile score and dichotomous variables for educational attainment (less than high school, GED, high school diploma graduate, some college, and college degree).

- **Length of initial term.** The length of the term chosen at enlistment is a potential indicator of a recruit's commitment to a military career. As a result, we expect the *monthly* risk of attrition to be lower for individuals selecting longer terms.[3] We include dichotomous variables for initial term of service: 2, 3, and 4+ years.

- **Months in the Delayed Entry Program (DEP).** Those soldiers who have waited the longest to begin active duty also display a commitment to military service that should be negatively correlated with attrition.

- **Demographic characteristics.** Because previous attrition studies have found significant differences in attrition rates by demographic characteristics, we include variables for race (white, black, and other), gender, and marital status at entry to active duty.

- **Military occupation.** The living conditions of an enlisted person vary significantly with his or her occupation, affecting attrition rates. We include dichotomous variables for six occupational categories (defined by DOD occupational codes): combat (0), electronics and communications (1,2), medical and other technical (3,4), administrative and support (5), mechanics and craftsmen (6,7), and service and supply (8).

- **Enlistment incentives.** We test whether eligibility for either the ACF or an enlistment bonus affects a soldier's probability of first-term attrition by including dichotomous variables for ACF eligibility and enlistment bonus levels ($1-1,500; $1,501-$3,000; $3,001+).[4]

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2. See Hogan et al. for an economic model of attrition that provides a theoretical rationale for the variables included in this list.

3. Term completion rates, however, may still be lower for those with longer initial terms because they are "exposed" to the risk of attrition over more months.

4. We consider a soldier to be "ACF-eligible" if he has an AFQT score greater than 50, is a high school diploma graduate, and enlists in an occupation that was included in the ACF program during FY82. (There is an education benefits variable on the cohort file that records program eligibility, but ACF-eligibility rates calculated from this variable were too low.) In contrast to defining ACF

We model first-term attrition behavior using parametric hazard models based on the Weibull and exponential distributions. Hazard models are often used when the dependent variable is a measure of time, such as promotion times or unemployment spell lengths, and the specific formulation based on the Weibull distribution has been found to provide a good representation of first-term attrition by Baldwin and Daula. In our analysis we found that the simpler exponential hazard model also fits the data well (see below), and so we describe that specific formulation here.

Let t_i be the months an individual serves in the Army. In the exponential hazard model, t_i is assumed to be distributed

$$(1) \qquad f(t_i) = \lambda_i \exp(-\lambda_i t) \qquad \text{where } \lambda_i = \exp(-\sum \beta_j X_{ij})$$

The X's are the soldier characteristics described above, and the β's are parameters to be estimated. As is typical in data on the time it takes to complete a particular event, we cannot observe all the t's in the EBCF because it only tracks sample members for seven years. Excluding these individuals from the analysis would obviously bias the results towards higher attrition. We can, however, include soldiers with incomplete or censored service times in the model by recognizing that we do know the probability that their actual service times are greater than the censored time. In particular,

$$(2) \qquad pr\ (t_i > c) = \int_c^\infty f(t)\, dt = \exp(-\lambda_i t)$$

where c is the censoring time. Using equations (1) and (2), the parameters of the exponential hazard model can be estimated by maximum likelihood methods.[5]

Results. The parameters of the hazard models are estimated using a sample of the EBCF. The sample statistics for the analysis file, which are shown in table C.2, are similar to the characteristics of the accession sample used to estimate the usage models in Appendix B. In addition

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eligibility from program rules, enlistment bonus eligibility is determined directly from accession records, which only include ranges of bonus payments.

5. For a more detailed description of hazard models, see Kalbfleisch and Prentice (1980).

to the demographic and service characteristics already discussed, the analysis sample has an average months in DEP of less than one and about 50% of the soldiers received an enlistment bonus.[6]

Table C.2. Sample means for attrition models

Variable	Mean[a]	Variable	Mean
Mean AFQT[b]	51.3	Term of enlistment (%)	
		2 years	6.8
Education (%)[b]		3 years	57.0
<High school	7.8	4 years	36.0
GED	1.8		
High school	82.0	Occupation categories (%)	
Some college	6.5	Combat	34.0
College	1.9	Electronics/Communication	18.0
		Technical	6.7
Race (%)		Administrative	13.0
White	70.7	Mechanical/Craftsmen	15.0
Black	25.0	Service	13.0
Other	5.5		
		Mean months in DEP	0.6
Female (%)	10.0		
		Enlistment Bonus (%)	
Married(%)[b]	12.0	$1-1,500	5.2
		$1,501-3,000	33.0
Army College Fund (%)[c]	30.0	$3,001+	8.9

a. Sample is a one-in-fifty random sample of the FY82 EBCF. Sample size equals 1,606.
b. Measured at accession.
c. Eligible for ACF at enlistment.

Table C.3 reports the results of estimating both the Weibull and exponential hazard models. The Weibull model has a more flexible functional form which reduces to the exponential model when

6. The incidence of enlistment bonuses, especially the distribution by initial term length, raises questions about the accuracy of the enlistment bonus information in the EBCF. Because bonus effects are not central to the cost-effectiveness analysis, we did not attempt to construct a policy-based variable similar to that used for ACF eligibility.

the Weibull shape parameter is 1. The estimate of the shape parameter for the results in table C.3 is 0.96 with a standard error of 0.05, implying that the simpler exponential model adequately represents attrition behavior in the EBCF. Because the parameters of a hazard model are not easily interpretable, table C.3 also includes the derivatives of expected months of first-term service with respect to the explanatory variables.[7]

The attrition model results are generally consistent with previous estimates, in particular:

- Soldiers with no high school diploma or a GED are estimated to serve 3 to 4 fewer months during the first term than otherwise similar soldiers entering with a high school diploma.
- AFQT scores are positively correlated with first-term service. A 30-point difference is estimated to increase service by about a month.
- Nonwhite and male soldiers have lower first-term attrition, holding constant other characteristics.
- A soldier's occupation has a significant effect on expected first-term service with the highest attrition in the combat and services MOSs.
- The longer a soldier spends in DEP before entering active duty, the lower his or her first-term attrition.

In comparison with the existing literature on attrition, the only surprising result is that the initial term of enlistment does not significantly affect the monthly rate of attrition.

We find that soldiers who enlist with ACF eligibility have more months of expected first-term service, other things being equal; but this result is neither significantly different from zero in a statistical sense nor large in magnitude. Similar results hold for the enlistment bonus. Thus, this analysis confirms previous estimates -- controlling for other characteristics, soldiers with enlistment

7. For the exponential hazard model, expected man-years during the first term of service for soldier i is given by

$$E(Y_i) = (1/\lambda_i)[1-\exp(-\lambda_i t_{TOE})$$

where the initial term of enlistment is given by t_{TOE} and differences in enlistment incentives enter the formula through the λ's. The derivatives are evaluated for a 3-year enlistment term.

Table C.3. Attrition model results

Variables	Weibull Model Coefficient		Exponential Model Coefficient		Exponential Model Derivative[a]
AFQT	.0075	(2.1)[b]	.0072	(2.2)	.032
Education (< High school)					
GED	-.15	(-.51)	-.14	(-.52)	-.67
High school	.90	(4.8)	.86	(5.1)	3.8
Some college	.73	(2.7)	.70	(2.8)	3.1
College	1.0	(2.2)	.99	(2.2)	4.4
Race (White)					
Black	.54	(4.0)	.52	(4.1)	2.3
Other	.41	(1.7)	.39	(1.8)	1.7
Female	-.77	(-4.5)	-.74	(-4.7)	-3.3
Married	-.0078	(-.052)	.0075	(.052)	.034
Army College Fund	.13	(.73)	.12	(.74)	.54
Term of Enlistment (3 Years)					
2 Years	-.22	(-.75)	-.23	(-.83)	
4 Years	-.19	(-1.5)	-.17	(-1.5)	
Occupation Categories (Combat)					
Electronics/Communication	.53	(2.8)	.51	(2.9)	2.3
Other Technical	.63	(2.3)	.61	(2.3)	2.7
Administrative	.72	(2.9)	.69	(2.9)	3.1
Mechanical/Craftsman	.49	(2.4)	.47	(2.4)	2.1
Services	-.10	(-.45)	-.096	(-.45)	-.43
Months in DEP	.098	(2.9)	.094	(2.9)	.42
Enlistment Bonus ($0)					
1 - 1,500	.30	(1.1)	.29	(1.1)	1.3
1,501 - 3,000	.034	(.18)	.033	(.19)	.15
3,001 +	.12	(.57)	.11	(.58)	.54
Intercept	3.2	(10.8)	3.2	(11.3)	

a. Change in expected months of first-term service with a small change in the explanatory variable.
b. The t-statistics are in parentheses.

incentives are neither more nor less likely to complete their first term of service.

Given these results, we assume no difference between ACF-eligible and noneligible soldiers in predicting first-term man-years for the cost-effectiveness analysis. Table C.4 displays the resulting predictions, as well as annual survival rates -- the probabilities defined in equation (2). The predictions are generated using the parameters in table C.3 and the mean characteristics for *high-quality soldiers* in the FY82 EBCF.[8]

Table C.4. Attrition model predictions

Variable[a]	Enlistment Term 2 Years	3 Years	4 Years
Survival rates:[b]			
1 year	.916	.921	.905
2 years	.838	.848	.820
3 years			.742
4 years			.672
Expected first-term manyears	1.75	2.55	3.14

a. Calculated using the exponential model parameter estimates in table C.3 and the mean characteristics of high-quality accessions in the EBCF.
b. The probability of having years of service greater than the indicated value.
c. Equals the sum of the survival rates by year.

8. Data availability problems prevented us from predicting first-term man-years and reenlistment rates using the characteristics of the high-quality members of the FY89 accession cohort, upon which the rest of the cost-effectiveness analysis is based. However, using FY82 characteristics only affects the level of the man-year predictions for both ACF-eligible and other soldiers, which will have almost no impact on the results of the cost-effectiveness analysis.

C.3 REENLISTMENT ANALYSIS

Approach. In this analysis we use a reenlistment model similar to that used by Hogan et al. to predict reenlistment rates for soldiers enlisting with and without eligibility for ACF participation. Like the enlistment decision, reenlistment can be viewed as an occupational choice influenced by both the pecuniary and nonpecuniary aspects of a military career compared with civilian alternatives. To capture variation in the relative attractiveness of a military career across individual soldiers, we include the following explanatory variables:

- **Education and AFQT.** We cannot directly observe a soldier's potential civilian earnings, but we can include predictions from an earnings model (a structural specification) or directly include the variables that would appear in such a model (a reduced form specification). Years of education and AFQT are correlated with a soldier's potential civilian earnings and, to a lesser extent, with his or her military earnings through differences in promotion times. The education and AFQT variables for the reenlistment analysis are defined the same way as in the attrition model.

- **Military occupation.** The nonpecuniary factors of military service will vary by occupation. In addition, there are occupational differences in the value of military training and experience in the civilian labor market. We use the same set of occupation categories defined for the attrition model.

- **Reenlistment bonus.** Bonuses increase the pecuniary advantages of reenlisting and, therefore, the incentive to reenlist. In this reduced form specification, variation in bonuses is represented by the Selective Reenlistment Bonus (SRB) multiplier.

- **Demographic characteristics.** Race, gender, and marital status are correlated both with potential civilian earnings and with the relative nonpecuniary advantages of a military career.

- **Enlistment incentives.** Eligibility for the ACF and enlistment bonuses are included in the models to assess the effects of these incentives on reenlistment behavior.

The reenlistment model is estimated with all soldiers in the FY82 cohort who reach their first-term ETS.[9] Mean characteristics for the analysis file are displayed in table C.5. Because the dependent variable in the reenlistment model is dichotomous (reenlist or not), we use a probit model to estimate the relationship between the reenlistment decision and the variables listed above. In this model, the predicted reenlistment rate for soldier i is given by

$$R_i = \Phi(\textstyle\sum_j \alpha_j X_{ij}) \tag{3}$$

where R is the reenlistment rate, the X's are values of the explanatory variables listed above, the α's are parameters to be estimated, and Φ is the cumulative normal distribution function. Because the 2-year enlistment program in FY82 was focused on obtaining high-quality recruits for particular occupations, we estimate separate models for 2-year versus 3- and 4-year initial enlistments.

Results. Estimation results are shown in table C.6. As with the attrition models, probit parameters are difficult to interpret directly, so we include the derivatives of first-term reenlistment rates with respect to the explanatory variables.

In general, the reenlistment model results are consistent with existing research using similar model specifications, in particular:

- There are large differences in reenlistment rates by demographic groups. Whites have significantly lower reenlistment rates than other racial groups, other variables held constant. Females have higher first-term reenlistment rates and married soldiers are more likely to reenlist than those without dependents. In this reduced form model, these differences reflect both pecuniary factors, such as higher allowances for soldiers with dependents, and nonpecuniary factors that influence the reenlistment decision.

- Controlling for other variables, both AFQT and educational attainment at enlistment are not highly correlated with reenlistment rates.

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9. ETS information is not available on the cohort file. We assume that a soldier has reached his first-term ETS if he is still on active duty three months before his estimated ETS, which equals his accession date plus the number of months in his initial term of service. Without ETS information, we also cannot cleanly separate extensions from reenlistments. We assume that a soldier "reenlisted" if he is still on active duty six months after his estimated ETS date.

Table C.5. Sample means for the reenlistment models

Variable	Enlistment Term 2 Years	3 Years	4 Years
Mean AFQT[a]	71.1	45.7	55.8
Education (%)[a]			
<High school	0.0	.076	.024
GED	0.0	.023	.0056
High school	.86	.82	.86
Some college	.11	.061	.08
College	.023	.018	.025
Race (%)			
White	.87	.62	.73
Black	.10	.32	.23
Other	.035	.058	.042
Female (%)	.038	.13	.072
Married (%)[a]	.048	.11	.16
Army College Fund (%)[b]	.85	.21	.35
Occupation Categories (%)			
Combat	.29	.24	.43
Electronics/Communication	.14	.19	.24
Other Technical	.03	.08	.05
Administrative	.20	.17	.05
Mechanical/Craftsman	.13	.14	.22
Service	.19	.18	.01
Mean SRB multiple	.67	.48	.45
Enlistment bonus (%)			
0	.53	.68	.40
1 - 1,500	.056	.027	.079
1,501 - 3,000	.26	.21	.39
3,001 +	.15	.079	.13
Sample size[c]	480	3,301	2,149

a. Measured at accession.
b. Eligible for ACF at enlistment.
c. Sample includes all soldiers in the FY82 EBCF who reach their first-term ETS.

- Reenlistment rates are higher in the noncombat occupations; although after adjusting for other soldier characteristics, the differences are relatively small.

- Reenlistment rates are positively correlated with SRB levels, although the effect is small.[10]

We find that soldiers enlisting with ACF eligibility have lower first-term reenlistment rates than otherwise similar soldiers. The estimated difference is approximately 5 percentage points lower for those with initial terms of 3 or 4 years, which is consistent with the previous research described above.

The 12 percentage point estimate for 2-year soldiers confounds ACF and occupational differences in reenlistment rates and, as a result, is probably too large. In FY82 only high-quality soldiers could enlist for 2 years, and they were eligible for participation in the ACF only if they enlisted in what are generally perceived to be less attractive occupations. Thus, in this data set, we are unable to separate the ACF and occupational effects for 2-year enlistees. For this reason, we use the ACF parameter from 3- and 4-year models in predicting reenlistment rates for 2-year enlistments in the cost-effectiveness analysis.

One weakness of this analysis is that, with one cohort and separate models by enlistment term, it is not possible to include a continuous measure of education benefits and test for nonlinearity in the empirical relationship between education benefits and reenlistment rates. The ACF coefficient captures two effects: (1) self-selection at the enlistment point as those individuals with college aspirations opt for ACF occupations, and (2) the effect of ACF benefits on the demand for education at reenlistment time. When ACF benefits are reduced, it is possible that the former effect will respond more slowly than the latter, producing a nonlinear change in reenlistment rates. Even with reduced benefits, the ACF would still be the better choice for college-bound high school graduates. We test the implications of this point on the cost-effectiveness analysis by using both the measured reenlistment effect and an effect 50% as large.

10. Because higher bonuses are paid to those occupations with low reenlistment rates, estimates of the bonus-reenlistment effect using cross-sectional data, as in this analysis, usually underestimate the actual effect.

Table C.6. Reenlistment model results

Variables	2-Year Enlistments			3- and 4-Year Enlistments		
	Coefficient		Derivative[a]	Coefficient		Derivative
AFQT	.00039	(.076)[b]	.00010	.0014	(1.2)	.0055
Education (< High school)						
GED				-0.74	(-.48)	-.029
High school				-.097	(-1.2)	-.038
Some college	.031	(.15)	.0082	-.071	(-.70)	-.028
College	-.39	(-.77)	-.10	.099	(.67)	.039
Race (White)						
Black	.52	(2.4)	.14	.42	(9.8)	.17
Other	.16	(.43)	.042	.26	(3.2)	.10
Female	.21	(.60)	.055	.30	(5.0)	.12
Married	.57	(2.0)	.15	.50	(9.4)	.20
Army College Fund	-.47	(-2.1)	-.12	-.12	(-2.1)	-.047
Occupation Categories (Combat)						
Electronics/Comm	.18	(.78)	.047	.071	(1.2)	.028
Technical	.53	(1.4)	.14	.21	(2.5)	.083
Administrative	-.12	(-.41)	-.032	.082	(1.1)	.032
Mechanical/Craftsman	-.65	(-2.0)	-.17	.0082	(.12)	.0032
Service	-.015	(-.05)	-.0040	.11	(1.3)	.043
SRB multiple	.069	(.80)	.018	.021	(.95)	.0083
Enlistment bonus ($0)						
1 - 1,500	-.22	(-.51)	-.058	-.058	(.62)	-.023
1,501 - 3,000	-.0045	(-.02)	-.0012	-.085	(-1.4)	-.033
3,001 +	-.076	(-.28)	-.020	.011	(.16)	.0043
4-Year Enlistment				.21	(5.1)	.083
Intercept	-.56	(-1.3)			-.36	(-3.1)

a. Change in reenlistment rate with small change in explanatory variable.
b. The t-statistics are in parentheses.

Table C.7 displays the reenlistment rates used in the cost-effectiveness analysis to calculate expected man-years. They are predicted using the coefficients in table C.6 (with the exception of the 2-year ACF effect) and the mean characteristics, by term of service, of the high-quality accessions in the FY82 EBCF.

Table C.7. Predicted reenlistment rates*

	Enlistment Term		
ACF Benefits Level	2 Years	3 Years	4 Years
FY89 benefits	.295	.433	.489
Benefits reduced 50%			
Baseline case	.308	.456	.516
Nonlinear effect	.302	.445	.503
No ACF benefits	.322	.479	.544

* Calculated from the parameters in table C.6 and the mean characteristics of the high-quality accessions in the EBCF.

C.4 SUMMARY

Unlike other recruiting incentives, the deferred benefits of the ACF offer an inducement for members to leave the service. In this Appendix, we estimated multivariate models of first-term attrition and reenlistment to test for ACF retention effects. We found no significant attrition difference between otherwise similar soldiers who were and were not eligible for the ACF; but we did find lower reenlistment rates, other things being equal, for ACF-eligibles. The estimated models provide two of the elements -- first-term man-years and reenlistment rates -- required to calculate expected man-years in the cost-effectiveness analysis.

C.5 REFERENCES

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APPENDIX D

SUPPLEMENTARY TABLE

Table D.1. Baseline case results by enlistment term (TOE)

	TOE 2		TOE 3		TOE 4	
	ACF	Other	ACF	Other	ACF	Other
As of FY89						
Man-years:						
High-quality male enlistments	5,950	2,447	5,775	1,892	38,000	21,755
Man-years per enlistment	3.88	4.07	5.67	6.00	6.65	7.05
Total man-years	23,057	9,961	32,722	11,345	25,281	153,411
Costs:						
Incentive cost/enlistment ($)	1,561	0	1,342	461	1,153	1,829
Training cost/enlistment ($)	17,000	17,000	17,000	17,000	17,000	17,000
Total costs (M$)	110	42	106	33	69	410
With 50% reduction in ACF						
Man-years:						
High-quality male enlistments	5,344	2,534	5,187	1,959	3,413	22,527
Man-years per enlistment	3.97	4.07	5.83	6.00	6.85	7.05
Total man-years	21,226	10,315	30,244	11,748	23,388	158,856
Costs:						
Incentive cost/enlistment ($)	880	199	698	718	561	2,959
Training cost/enlistment ($)	17,000	17,000	17,000	17,000	17,000	17,000
Total costs (M$)	96	44	92	35	60	450
Change (Reduced ACF - FY89)						
Man-years	-1,830	354	-2,478	403	-1,893	5,445
Total costs (M$)	-15	2	-14	2	-9	40